



**CLEAN DEVELOPMENT MECHANISM
PROJECT DESIGN DOCUMENT FORM (CDM-PDD)
VERSION 03 - IN EFFECT AS OF: 28 JULY 2006**

CONTENTS

- A. General description of project activity.
- B. Application of a baseline and monitoring methodology
- C. Duration of the project activity / crediting period
- D. Environmental impacts
- E. Stakeholders' comments

Annexes

- Annex 1: Contact information on participants in the project activity
- Annex 2: Information regarding public funding
- Annex 3: Baseline information
- Annex 4: Monitoring plan

**SECTION A. General description of project activity.****A.1. Title of the project activity:**

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Use of waste gas at Namakwa Sands in South Africa

Version: 06

Date: 25/11/2011

A.2. Description of the project activity:

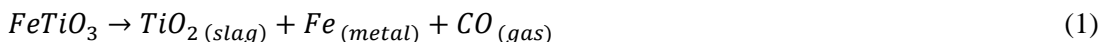
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- (i) Purpose of the project

The purpose of the project is to reduce greenhouse gas emissions by utilising waste gas from a smelter operation. The waste gas will be used for the generation of electricity.

The *Exxaro Resources Ltd* owned *Exxaro TSA Sands (Pty) Ltd* smelter (referred to from this point on as Namakwa Sands) is a heavy minerals mining and beneficiation business located in South Africa. This business encompasses mining, mineral concentration, separation, and smelting operations. The smelting operation commenced in 1994 in the Western Cape Province, near the town of Saldanha Bay. The smelting operation consists of two closed, DC-arc furnaces: Furnace 1 (with an electrical capacity of 25 MW and a tapping capacity of 20 tonnes of slag every 2 hours and 30 tonnes of metal every 4 hours) and Furnace 2 (with an electrical capacity of 35 MW and a tapping capacity of 25 tonnes of slag every 1.5 hours, and 30 tonnes of metal every 2.5 hours). Inside these furnaces, the reduction of mined ilmenite to produce titania (TiO₂) slag and iron (Fe) occurs. The reduction of mined ilmenite requires the presence of a carbon-rich reductant. Typical reductants that are used by smelting operations are anthracite, char and/or coke.

The reduction of mined ilmenite is represented by reaction (1).



The carbon monoxide (CO) gas is formed as a result of the presence of the carbon in the reductant. If the reductant contains volatile hydrocarbons, as is the case at Namakwa Sands, hydrogen (H₂) gas is also formed. This CO and H₂ gas is referred to as furnace off-gas. Currently, the majority of the furnace off-gas is cleaned and then flared. The flaring of the cleaned gas is a safety measure, as carbon monoxide is extremely poisonous. Cleaning of the gas prior to flaring is required to reduce the particulate emissions from the flares. However, the flaring of the off-gas means that the energy inherent in the gas is not utilised.

The project will use this cleaned furnace off-gas, which was previously flared, to primarily generate electricity using internal combustion engines. The actual quantity of gas available for the project depends on the furnace performance and availability.



The performance of the engines with this specific gas is uncertain as it is a first of its kind. However, GE Jenbacher has guaranteed an electrical output of 1698 kW per engine for this project¹. GE Jenbacher has been selected as the gas engine supplier for this project activity however; Exxaro Resources Ltd can only sign a contract with the supplier when a positive validation report is received.

The internal combustion engines will be installed in a phased approach. Six engines will be installed in Phase 1, with an additional two engines installed in Phase 2. Therefore, at the completion of both phases the engines will displace a guaranteed 13.6 MW² of electricity, resulting in emission reductions of an average of 88,298 tCO₂e/ year. The electricity will be used by the Namakwa Sands smelting operation, thus resulting in a reduction of electricity purchased from Eskom (South Africa's national electricity provider).

The project timeline is as follows:

- Board approval for Capital Expenditure at the board meeting in August 2011.
- Project implementation and ordering of equipment to commence on 1 September 2011.
- Date of commissioning on 1 September 2012.

(ii) Greenhouse gas reduction:

The electricity generated from the furnace off-gas will displace electricity from the project electricity system. According to the 'Tool to calculate the emission factor for an electricity system' (Version 02.2.1), a project electricity system is defined by the power plants that are physically connected through transmission and distribution lines to the project activity and that can be displaced without significant transmission constraints.

Namakwa Sands currently purchases its electricity from Eskom. Eskom is physically connected to the Southern African Power Pool³. Therefore, for this project activity, the project electricity system comprises of all power plants within the SAPP. Electricity from the SAPP is predominantly generated from sub-bituminous coal, with a low heat value and a high ash content (83% of the electricity is from coal fired power stations). Owing to the use of coal and, more specifically, low quality coal, the emission factor of the SAPP is 1.04 tonnes CO₂/MWh. This value was calculated using the 'Tool to calculate the emission factor for an electricity system' (Version 02.2.1), and these calculations will be provided during validation.

¹ GE Jenbacher engine specifications

² 13.58 MW rounded to one decimal place

³ Eskom. (2010, October). Eskom and the Southern African Power Pool (SAPP). Retrieved from www.eskom.co.za/content/ES_0007SAfPowPoolRev5.pdf



(iii) Contribution to sustainable development:

The project makes positive contributions to sustainable development. The South African Designated National Authority (DNA) evaluates sustainability in three categories: economic, environmental, and social. The contribution of the project towards sustainable development is discussed in terms of these three categories:

Economic

There will be a transfer of technology from a developed country to a developing country. The internal combustion engines that are used to generate the electricity will be sourced from GE Jenbacher in Austria (Annex-1 country) and will be imported to South Africa.

Internal combustion engines are currently used in only five other South African registered CDM projects:

- The first of these projects is the ‘PetroSA Biogas to Energy Project’ (Project 0446), which was registered by the CDM EB on the 29/09/2006. In this project, the engines operate on biogas composed primarily of methane.
- In the second project, the engines run on landfill gas released from Durban’s landfill sites. This project was registered as a CDM project by CDM EB on the 15/12/2006 and is titled ‘Durban Landfill Gas-to-Electricity Project – Mariannhill and La Mercy’ (Project 0545).
- The third project, titled ‘Kanhym Farm manure to energy project’ (registered under CDM on 18/07/2008 – project 1665), uses biogas from a piggery to generate electricity using an internal combustion engine.
- The fourth and fifth projects also use landfill gas to operate their internal combustion engines. These projects are titled ‘Durban Landfill-Gas Bisaser Road’ (registered under CDM on 26/03/2009 – project 1921), and ‘Alton Landfill Gas to Energy Project’ (registered under CDM on 24/08/2009 – project 2549).

These projects are all biogas projects, and differ fundamentally from the Namakwa Sands project. The main difference lies in the fact that the fuel gas of the proposed project does not contain any methane, but rather carbon monoxide and hydrogen. In addition, the projects mentioned above operate the engines on gas with a significantly higher calorific value than the furnace off-gas that this project will use.

There will be a transfer of knowledge as personnel responsible for the operation and maintenance of the engines will receive the necessary training.

*Environmental*

The proposed project activity will have a positive regional environmental impact. It will lower the environmental impacts of coal based power generation. This includes the amount of sulphur dioxide released due to the combustion of low grade coal, particulate emissions, water demand of coal based power generation, and the environmental impact of ash disposal.

The project will also have a positive local environmental impact. It will remove additional particulates from the furnace off gas. The gas, previously flared, will be filtered to minimise the particulate loading of the gas. The particulates trapped by the filters will be removed with water and be routed to the existing thickener. This will lead to improvements in the local air quality.

The proposed project will not change the current local water availability or access. Neither will the project have an impact on the current local water quality. The current soil condition at Namakwa Sands will not be affected by the project activity. The project will be located within an existing built up area at the Namakwa Sands Smelter, on already disturbed land. The project will, however, encourage more efficient use of natural resources and energy.

On a global scale, the project makes a contribution to greenhouse gas emission reduction.

Social

The project will create 11 jobs in the operations phase. The creation of jobs is important since the Namakwa Sands smelting operation is located in an area with very little established industries and, therefore, very few existing employment opportunities. The number of temporary jobs created in the construction phase has not been estimated, but similar projects estimate that the number of temporary jobs created is around 100 jobs. It is Exxaro Resources Ltd's policy to actively recruit labour from local communities wherever possible⁴. The creation of jobs is in line with the Saldanha Bay Municipality's Integrated Development Plan (IDP) for 2006-2011, which states that growing unemployment is one of the greatest challenges facing the municipality⁵.

⁴ Exxaro. (2009). Annual Report, page 122. Retrieved from <http://www.exxaro.com/content/investor/finreport.asp>

⁵ Saldanha Bay Municipality Integrated Development Plan 2006-2011, pages 8 and 43. Retrieved from http://www.capegateway.gov.za/Text/2008/4/idp_wc_saldanha_bay_2007.pdf

**A.3. Project participants:**

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Name of Party involved (*) (host) indicates a host Party)	Private and/or public entity(ies) project participants (*) (as applicable)	Kindly indicate if the Party involved wishes to be considered as project participant (Yes/No)
Republic of South Africa	Exxaro Resources Ltd	No
Republic of South Africa	Exxaro TSA Sands (Pty) Ltd: Namakwa Sands	No

A.4. Technical description of the project activity:**A.4.1. Location of the project activity:****A.4.1.1. Host Party(ies):**

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The host party is the Republic of South Africa.

A.4.1.2. Region/State/Province etc.:

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The project is located in the Western Cape Province.

A.4.1.3. City/Town/Community etc.:

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The project is located approximately 15km from the town of Saldanha Bay.

A.4.1.4. Details of physical location, including information allowing the unique identification of this project activity (maximum one page):

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The project will be situated as near to the source of the furnace off-gas as possible in order to minimise the safety risks involved in transporting the off-gas. Therefore, the plant will be located at the Namakwa Sands' smelting operations in South Africa. The site is located within the Saldanha Bay Local Municipality, which is one of the municipalities encompassed under the West Coast District Municipality in the Western Cape. The site is 15 km from the towns of Vredenburg and Saldanha and is off the coastal road the R27.

The location of the proposed project activity is shown below:



Figure 1: The provincial location of the project activity



Figure 2: The location of the project activity, which is at the Namakwa Sands smelting facility

The new project facility will be located at the following GPS coordinates:

32°57'43" S

18°02'39" E

A.4.2. Category (ies) of project activity:

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Sectoral scope 01: Energy industries (renewable-/non-renewable sources)

Sectoral scope 04: Manufacturing industries

**A.4.3. Technology to be employed by the project activity:**

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Furnaces

Namakwa Sands operates two closed, DC-arc furnaces that were built by Aesa Brown Boveri:

- Furnace 1
 - Electrical capacity: 25 MW.
 - Tapping capacity: 20 tonnes of slag every 2 hours and 30 tonnes of metal every 4 hours.
- Furnace 2
 - Electrical capacity: 35 MW.
 - Tapping capacity: 25 tonnes of slag every 1.5 hours and 30 tonnes of metal every 2.5 hours.

Inside these furnaces, ilmenite is reduced to produce titania slag and iron. Along with titania slag and iron, a gas (furnace off-gas) composed primarily of carbon monoxide and hydrogen is produced.

The composition of the furnace off-gas varies, but the table below presents the average composition of the gas based on information supplied by Namakwa Sands:

Furnace	Component	Composition (vol. %)
Furnace 1	CO	73.0
	H ₂	14.5
Furnace 2	CO	75.5
	H ₂	16.5

The remainder of the gas is predominantly nitrogen with a small amount of carbon dioxide. The oxygen content is negligible since the furnace is set to trip at an oxygen content of 0.5 vol. %.

The volume of the gas available per year for cogeneration varies between $\pm 82,000,000 \text{ Nm}^3$ and $\pm 90,000,000 \text{ Nm}^3$, with the average over the period 2011 – 2026 at $87,500,000 \text{ Nm}^3$. The average gas flow rate over the period 2011 – 2026 is $11,898 \text{ Nm}^3/\text{hr}$.

At present, the off-gas is collected from the furnaces and cleaned and conditioned in the gas cleaning plant. If the gas cleaning plant is down for planned or unplanned maintenance then the gas is flared in the raw gas stack. However, under normal operation, the particulates in the gas are removed and the gas is cooled in the gas cleaning plant and the resulting clean gas is then routed to a gas buffer vessel. The clean gas is stored at 4.5kPa gauge in the gas buffer vessel. If the gas buffer vessel exceeds an upper limit of its maximum storage capacity, the clean gas is flared in the clean gas stack.



Currently, a small portion of the clean gas is extracted from the gas buffer vessel and used to dry anthracite. Anthracite is the reductant used in the furnaces to reduce ilmenite to titania slag and iron. This small portion of clean gas will still be used to dry the anthracite during the project activity. It is the rest of the gas, which was previously flared, that will be used in this project activity to generate electricity. The gas that is used to generate electricity will be extracted from the gas buffer vessel and further cleaned and conditioned. The gas must be further cleaned in order to meet the gas requirements as specified by the engine manufacturers.

Internal combustion engines

The electricity will be generated using internal combustion engines. The internal combustion engines are spark ignition engines operating on the same principles as normal petrol engines. These engines have electrical outputs of between 1.5 MW and 2 MW. The project activity will use as much of the off-gas that is currently flared in the internal combustion engines as possible.

GE Jenbacher has been selected as the gas engine supplier for this project activity however; Exxaro Resources Ltd can only sign a contract with the supplier when a positive validation report is received.

The GE Jenbacher internal combustion engines used in the project will be imported from an Annex-1 country in Europe. Therefore, there will be a technology transfer from an industrialised country in the northern hemisphere to a developing country in the southern hemisphere. These engines have been used at five other registered CDM projects in South Africa. These projects are:

- PetroSA Biogas to Energy Project (project 0446)
- Durban Landfill Gas-to-Electricity Project – Mariannhill and La Mercy (project 0545)
- Kanhym Farm manure to energy project (project 1665)
- Durban Landfill-Gas Bisaser Road (project 1921)
- Alton Landfill Gas to Energy Project (project 2549)

These projects are all biogas projects and differ fundamentally from the Namakwa Sands project. The main difference lies in the fact that the fuel gas of this project does not contain any methane, but rather carbon monoxide and hydrogen.

This project also aims to be the first CDM registered project in South Africa to operate the engines on the low calorific value waste gas at a smelter. Therefore, there will be knowledge innovation from this project. Knowledge transfer will also take place as the relevant personnel will be trained in the operation of the engines.

The actual performance of the engines is still unknown as there is no reference plant running on gas with comparable hydrogen and carbon monoxide content. This technological risk will be addressed by installing a conservative amount of engines at the beginning of the project. Their electrical output will be closely monitored during the first months of operation. If the engines reach/are close to their maximum

electrical output, no further engines will be installed. However, if they do not operate near their maximum expected electrical output; additional engines will be installed when required.

Existing and proposed furnace off-gas system

Below is a schematic of the existing (currently done at Namakwa Sands) and new (proposed by the project activity) furnace off-gas system:

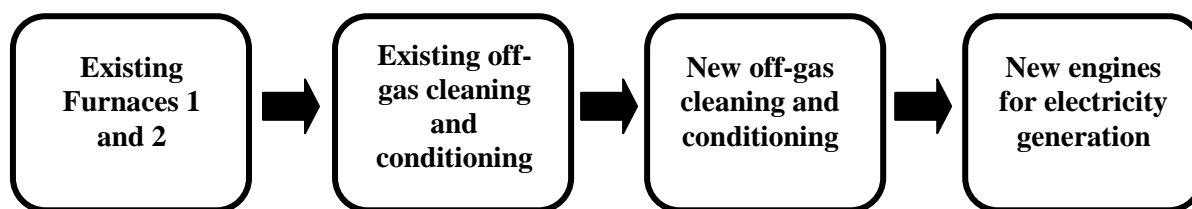


Figure 3: Schematic of furnace off gas system

Process flow diagram of the off gas system and project activity

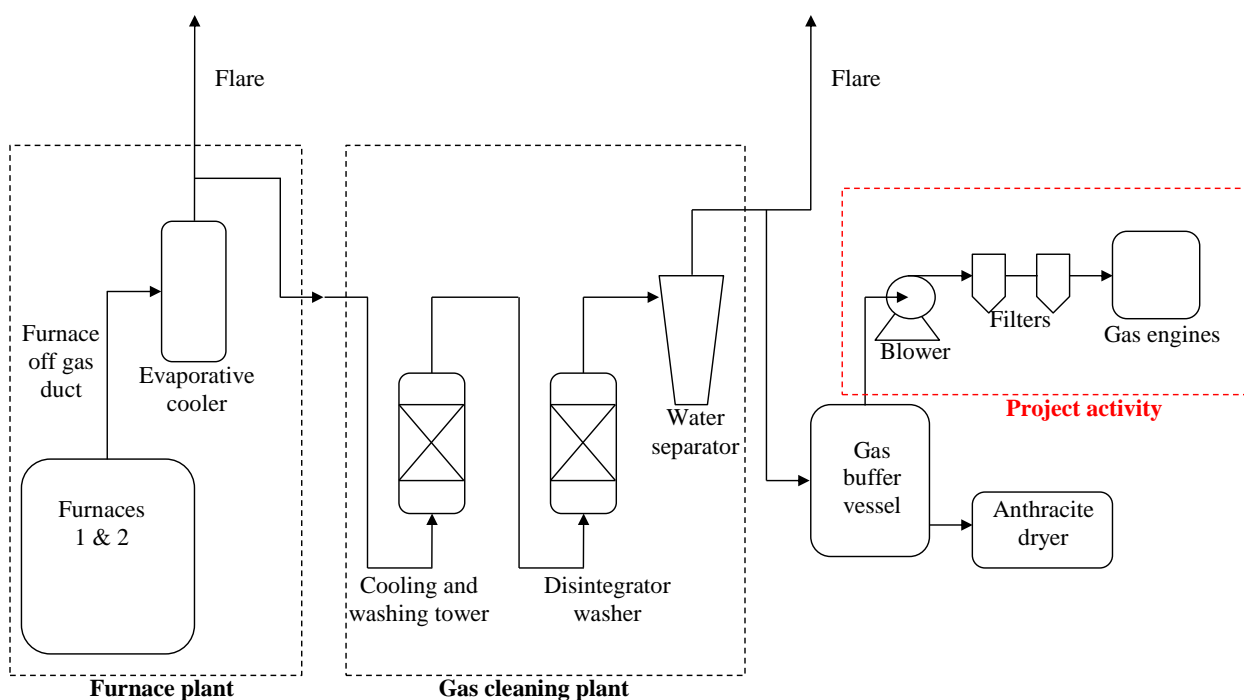


Figure 4: Process flow diagram of off gas system and the project activity

**A.4.4. Estimated amount of emission reductions over the chosen crediting period:**

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Year	Annual estimation of emission reductions in tonnes of CO ₂ e
2013	74,801
2014	82,336
2015	83,141
2016	85,621
2017	85,734
2018	85,734
2019	85,734
2020	82,326
2021	85,734
2022	85,621
Total estimated reductions (tonnes of CO ₂ e)	836,771
Total number of crediting years	10
Annual average over the crediting period of estimated reductions (tonnes of CO ₂ e)	83,677

A.4.5. Public funding of the project activity:

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No public funding has been used in the development of this project and no public funding will be used in its implementation. Official Development Assistance (ODA) has not and will not be used in the development and implementation of this project.

SECTION B. Application of a baseline and monitoring methodology**B.1. Title and reference of the approved baseline and monitoring methodology applied to the project activity:**

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The approved baseline and monitoring methodology is ACM0012: ‘Consolidated baseline methodology for GHG emission reductions from waste energy recovery projects’, Version 03.2, Sectoral Scopes 01 and 04, EB 51.

The following methodological tools were used:

- ‘Tool to calculate the emission factor for an electricity system’ (Version 02.2.1)
- ‘Tool for the demonstration and assessment of additionality’ (Version 05.2)

**B.2. Justification of the choice of the methodology and why it is applicable to the project activity:**

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The following table summarises the main applicability criteria's for projects using ACM0012 (version 03.2) is intended. This project activity meets all of the criteria – this is justified in the table below.

Item	ACM0012 (version 03.2)	Project Activity
1	<p><i>The consolidated methodology is for the following types of project activities:</i></p> <p><i><u>Type-1:</u> All the waste energy in identified Waste Energy Carrying Medium (WECM) stream/s that will be utilized in the project activity is, or would be flared or released to atmosphere in the absence of the project activity at the existing or new facility. The waste energy is an energy source for:</i></p> <ul style="list-style-type: none"> • <i>Cogeneration; or</i> • <i>Generation of electricity; or</i> • <i>Direct use as process heat source; or</i> • <i>For generation of heat in element process (e.g. steam, hot water, hot oil, hot air);or</i> • <i>For generation of mechanical energy.</i> <p><i><u>Type-2:</u> An existing industrial facility, where the project activity is implemented, that captures and utilizes a portion of the waste gas stream(s) considered utilized in the project activity, and meet the following criteria:</i></p> <ul style="list-style-type: none"> • <i>The project activity is to increase the capture and utilization of waste gas for generation of electricity that is flared or vented in the absence of the project activity, and not only the replacement/modification/expansion of existing generation equipment with or to a more efficient equipment;</i> • <i>The portion of waste gas captured prior to implementation of the project activity is used for generation of captive electricity. The use of a portion of the waste gas in the baseline for the purpose of heat generation or other use prior to implementation of the project activity is also permitted under this methodology provided the generation of heat or other use in crediting period remain same as that in the baseline;</i> • <i>If the project participant uses a part of the electricity</i> 	<p>This is a Type-1 project activity. The waste energy is an energy source for the generation of electricity. The waste gas was previously flared. This will be demonstrated by an energy balance of the relevant sections of the plant (refer to Annex 3); to prove that waste energy to be used in the project was not a source of energy before the implementation of the project activity.</p>



	<p><i>generated in the project activity onsite and exports the remainder, both shall be monitored. In such situations it shall be demonstrated that the electricity generated for own consumption from waste gas is not reduced in the project activity;</i></p> <ul style="list-style-type: none"> <i>Emission reductions generated in the project activity are attributable to the amount of waste gas captured and utilized in the project activity that was flared or vented in the absence of the project activity and to the increase in energy efficiency of the new power generating facility;</i> <i>No auxiliary fossil fuel (except start-up fuel) is used in the waste gas boiler for the generation of captive electricity in the absence of the project.</i> <p><i>For project activities that use waste pressure, the consolidated methodology is applicable where waste pressure is used to generate electricity only.</i></p>	
2	<i>If the project activity is based on the use of waste pressure to generate electricity, electricity generated using waste pressure should be measurable;</i>	Waste pressure will not be used to generate electricity at Namakwa Sands.
3	<i>Energy generated in the project activity may be used within the industrial facility or exported from the industrial facility;</i>	The energy generated in the project activity will be used at Namakwa Sands.
4	<i>The electricity generated in the project activity may be exported to the grid or used for captive purposes;</i>	The electricity generated by the project activity will be used at Namakwa Sands.
5	<i>Energy in the project activity can be generated by the owner of the industrial facility producing the waste energy or by a third party (e.g. ESCO) within the industrial facility;</i>	The energy will be generated by Exxaro Resources Ltd, the owner of Namakwa Sands.
6	<i>Regulations do not constrain the industrial facility that generates waste energy from using fossil fuels prior to the implementation of the project activity;</i>	Anthracite is currently fed into the furnaces. The reaction in the furnaces leads to the generation of waste gas. The generation of waste gas from fossil fuels is in line with South Africa's regulations.
7	<i>The methodology covers both new and existing facilities. For existing facilities, the methodology applies to existing capacity. If capacity expansion is planned, the added capacity must be treated as a new facility;</i>	Namakwa Sands is an existing facility.



8	<i>The emission reductions are claimed by the generator of energy using waste energy;</i>	Exxaro Resources Ltd is the generator of energy using waste energy. Exxaro Resources Ld will solely claim the emission reductions. Namakwa Sands will not claim any emission reductions from the project activity.
9	<i>In cases where the energy is exported to other facilities, an official agreement exists between the owners of the project energy generation plant (henceforth referred to as generator, unless specified otherwise) with the recipient plant(s) that the emission reductions would not be claimed by recipient plant(s) for using a zero-emission energy source;</i>	The energy will be used at Namakwa Sands and not exported to other facilities. The emission reductions will be claimed by the generator of energy (Exxaro Resources Ltd).
10	<i>For those facilities and recipients included in the project boundary, that prior to implementation of the project activity (current situation) generated energy on-site (sources of energy in the baseline), the credits can be claimed for minimum of the following time periods:</i> <ul style="list-style-type: none"> • <i>The remaining lifetime of equipments currently being used</i> • <i>Credit period.</i> 	Currently, there is no electricity generation on-site.
11	<i>Waste energy that is released under abnormal operation (for example, emergencies, shut down) of the plant shall not be accounted for.</i>	The waste gas released under abnormal operation of the plant will not be accounted for.
12	<i>This methodology is <u>not</u> applicable to projects where the waste gas/heat recovery project is implemented in a single-cycle power plant (e.g. gas turbine or diesel generator) to generate power.</i>	The project activity is implemented in an ilmenite smelter (not a single-cycle power plant), and therefore this methodology is applicable.

B.3. Description of the sources and gases included in the project boundary:

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As per methodology ACM0012, the project boundary includes the sources related to project emission and baseline emission. Therefore, the project boundary is defined as:

- The facility generating the furnace off-gas;
- The proposed electricity generation plant, which will generate electricity from the furnace off-gas;
- The facility using the electricity, which in this case is the same as the facility generating the furnace off-gas; and
- The electricity grid, to the extent of determining the grid emission factor.

The project boundary is illustrated in Figure 5 below:

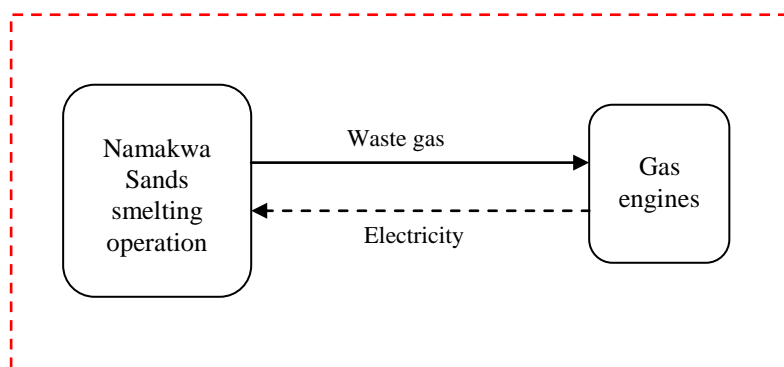


Figure 5: Project boundary of the project activity

Table 1: Summary of gases and sources included in the project boundary and justification explanation where gases and sources are not included

	Source	Gas	Included?	Justification / Explanation
Baseline	Electricity generation, grid	CO ₂	Included	Main emission source.
		CH ₄	Excluded	Excluded for simplification. This is conservative.
		N ₂ O	Excluded	Excluded for simplification. This is conservative.
	Fossil fuel consumption in boiler for thermal energy	CO ₂	Excluded	Not applicable. The project activity does not involve the generation of thermal energy from waste gas.
		CH ₄	Excluded	Not applicable. The project activity does not involve the generation of thermal energy from waste gas..
		N ₂ O	Excluded	Not applicable. The project activity does not involve the generation of thermal energy from waste gas.
	Fossil fuel consumption in cogeneration plant	CO ₂	Excluded	Not applicable. The project activity does not involve cogeneration.
		CH ₄	Excluded	Not applicable. The project activity does not involve cogeneration.
		N ₂ O	Excluded	Not applicable. The project activity does not involve cogeneration.
	Baseline emissions from generation of steam used in the flaring process, if any	CO ₂	Excluded	Not applicable. Steam is not used in the flaring process.
		CH ₄	Excluded	Not applicable. Steam is not used in the flaring process.
		N ₂ O	Excluded	Not applicable. Steam is not used in the flaring process.
Project	Supplemental	CO ₂	Included	Main emission source.



Activity	fossil fuel consumption at the project plant	CH ₄	Excluded	Excluded for simplification.
		N ₂ O	Excluded	Excluded for simplification.
	Supplemental electricity consumption	CO ₂	Included	Main emission source.
		CH ₄	Excluded	Excluded for simplification.
		N ₂ O	Excluded	Excluded for simplification.
	Electricity import to replace captive electricity, which was generated using waste gas in absence of project activity	CO ₂	Excluded	Not applicable. The baseline does not involve captive electricity.
		CH ₄	Excluded	Not applicable. The baseline does not involve captive electricity.
		N ₂ O	Excluded	Not applicable. The baseline does not involve captive electricity.
	Project emissions from cleaning of gas	CO ₂	Included	Main emission source.
		CH ₄	Excluded	Excluded for simplification.
		N ₂ O	Excluded	Excluded for simplification.

B.4. Description of how the baseline scenario is identified and description of the identified baseline scenario:

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The baseline scenario was identified as the most plausible baseline scenario among all realistic and credible alternatives. A stepwise approach is used, as per methodology ACM0012.

Step 1: Define the most plausible baseline scenario for the generation of heat and electricity using the following baseline options and combinations

Realistic and credible alternatives were determined for:

- Waste energy use in the absence of the project activity; and
- Power generation in the absence of the project activity.

Steam/heat and mechanical energy are not generated in the project activity and, therefore, realistic and credible alternatives for these need not be identified.

The alternatives for the use of the waste energy in the absence of the project activity are:

W1: WECM is directly vented to atmosphere without incineration or waste heat is released to the atmosphere or waste pressure energy is not utilized



This is not a feasible option since the waste gas cannot be directly vented to the atmosphere, and must be flared so as to prevent the accumulation of hazardous gas. Carbon monoxide is poisonous and extremely dangerous as it is a tasteless, odourless and invisible gas. Carbon monoxide can cause people to become unconscious and, if not given oxygen in time, it can cause death. The off-gas also contains hydrogen, which also forms an explosive mixture in air. Hence, W1 is not a feasible option, and is excluded from the realistic and credible alternatives.

W2: WECM is released to the atmosphere (for example after incineration) or waste heat is released to the atmosphere or waste pressure energy is not utilized

There are no barriers facing this alternative. The infrastructure and equipment necessary for flaring is already in place at Namakwa Sands for safety purposes, and therefore no additional capital expenditure would be required (no investment barrier). There are also no technological barriers to flaring the waste gas, as flares are available in South Africa. This is a realistic and credible alternative.

W3: Waste energy is sold as an energy source

The sale of the furnace off gas has been investigated, and preliminary negotiations were engaged with a potential buyer – a neighbouring steel mill. This is not a realistic and credible alternative due to the following:

- The potential buyer currently uses coal as a source of energy which is relatively cheap in South Africa.
- This company also generates its own waste gas of similar composition (carbon monoxide and hydrogen), which is currently flared and not used in their operation.
- The transport of waste gas to the buyer poses a significant safety risk. The gas would need to be piped over open land, thereby exposing members of the public to a potential safety hazard - the threshold limit value of carbon monoxide is 25ppm, and the explosion limits of carbon monoxide and hydrogen are 12% and 4% respectively.
- Namakwa Sands has also never had any other potential buyers for the furnace off-gas during the 15 years it has been in operation.

W3 also faces two prevailing practice barriers - it is not common practice to pipe gas of such hazardous composition, and it is also not common to use such a low calorific value waste gas in South Africa.

W4: Waste energy is used for meeting energy demand

Using the waste gas to meet energy demand would require capital expenditure that would not be required if the waste gas was flared, as is currently the case at Namakwa Sands. The low calorific value of the furnace off-gas makes it difficult to meet the energy demand of Namakwa Sands. The technology required for the use of low calorific gas (like furnace off-gas) for energy generation is not common at ilmenite smelters in South Africa. Two other similar projects are currently in the CDM validation phase - 'BioTherm Herculon Ferrochrome Cogeneration Project' and 'Cogeneration from Waste Smelter Gas at



Richards Bay Minerals in South Africa'. This illustrates a lack of prevailing practice and, for this reason; it is not a realistic and credible alternative.

W5: A portion of the waste gas produced at the facility is captured and used for captive electricity generation, while the rest of the waste gas produced at the facility is vented/flared

There is no existing power generation equipment at Namakwa Sands, and therefore using the waste gas to generate power would require a significant capital investment. The waste gas also has low calorific value, which means that a large amount of the gas would be required to generate a small amount of electricity or heat. As mentioned above, the technology required for the use of low calorific gas (like furnace off-gas) for energy generation, is not common at smelters in South Africa. The use of low calorific value waste gas is also not common at smelters in South Africa. Therefore, this is not a realistic and credible alternative.

W6: All the waste gas produced at the industrial facility is captured and used for export electricity generation

Due to the relatively cheap electricity price in South Africa, the price of the electricity produced from the waste gas is higher than the price of the electricity supplied by Eskom. Therefore, this is not a realistic and credible alternative.

The alternatives for power generation in the absence of the project activity are:

P1: Proposed project activity not undertaken as a CDM project activity

A large amount of furnace off-gas is required to generate a small amount of electricity, because the gas fluctuates in its supply and has a low calorific value. This, coupled with the significant capital investment of the project, makes the activity not feasible without the potential carbon credit revenue. Therefore, P1 is not a realistic and credible alternative.

P2: On-site or off-site existing/new fossil fuel fired cogeneration plant

There is no existing cogeneration plant on-site. The installation of a new fossil fuel fired cogeneration plant, together with the purchase of fuel, would require a significant capital investment. This would not be the case if the waste gas is flared and electricity is purchased from Eskom (as is currently the case at Namakwa Sands).

The availability of these fossil fuels is also limited. For example, natural gas⁶ and coal⁷ are not available in the vicinity of the proposed project activity (Western Cape Province). Importing other fuels through

⁶ de Pontes, M., Ellman, M., & Germuishuys, K. (2009). The natural gas industry in South Africa: Availability, sustainability and reliability of gas supply. Energy Efficiency Made Simple Volume II, 59-60.



shipping would require a considerable capital investment. Securing a cost effective supply of fossil fuel would be difficult considering the location of Namakwa Sands and the distance to transport these fuels. Therefore, P2 is not a realistic and credible alternative.

P3: On-site or off-site existing/new renewable energy based cogeneration plant

The cogeneration plant could involve a renewable energy such as biomass. This, however, is unlikely as the Namakwa Sands smelter is located in an arid region (mean annual precipitation of between 350 and 500mm⁸), which makes biomass not readily available in the vicinity of the proposed project activity⁹. Purchasing and importing biomass to the site would require a considerable capital investment, which is not required if the waste gas is flared and electricity is purchased from Eskom (as is currently the case at Namakwa Sands). Furthermore, the production of power from biomass would be more expensive than purchasing electricity from Eskom. This is not a realistic and credible alternative.

P4: On-site or off-site existing/new fossil fuel based existing captive or identified plant

As in P2, the availability of fossil fuel is limited. For example, natural gas and coal are not available in the vicinity of the proposed project activity (Western Cape Province). Importing other fuels through shipping would require a considerable capital investment. There is also no captive or identified plant at Namakwa Sands, and a new fossil fuel based captive or identified plant would require capital investment, which would not be required if the waste gas is flared and electricity is purchased from Eskom (as is currently the case at Namakwa Sands). This is not a realistic and credible alternative.

P5: On-site or off-site existing/new renewable energy or other waste energy based existing captive or identified plant

The renewable energies employed would probably be wind, solar, hydro or waste energy. The production of electricity from these energies would be more expensive than purchasing it from Eskom¹⁰. A new hydro, wind, solar, or waste energy captive or identified plant would require capital investment, which is not required if the waste gas is flared and electricity is purchased from Eskom (as is currently the case at Namakwa Sands).

⁷ Jeffrey, L. (2005). Characterization of the coal reserves of South Africa. The Journal of The South African Institute of Mining and Metallurgy, 95-102.

⁸ Department of Environmental Affairs and Tourism. (2000, July). Environmental Potential Atlas for South Africa: Mean Annual Precipitation. Retrieved from <http://www.environment.gov.za/enviro-info/nat/images/rain.jpg>

⁹ Damm, O., & Triebel, R. (2008). A Synthesis Report on Biomass Energy Consumption and Availability in South Africa. South Africa: LHA Management Consultants.

¹⁰ National Energy Regulator of South Africa. (2009, October 30). *Decision in the matter regarding Renewable Energy Feed-In Tariffs Phase II by the National Energy Regulator of South Africa, pages 10 and 14.*



P6: Sourced Grid-connected power plants

Namakwa Sands has the capacity to obtain all of its required electricity from South Africa's national electricity provider, Eskom. This occurs currently, and is a realistic and credible alternative.

P7: Captive Electricity generation using waste energy (if project activity is captive generation using waste energy, this scenario represents captive generation with lower efficiency than the project activity)

In South Africa, most of the electricity generation capacity is Eskom (South Africa's national utility). The non-Eskom generation capacity is linked to four municipality-owned (local government) power stations – Kelvin A, Kelvin B, Pretoria West and Rooival. The only privately owned company generating electricity is Sasol, with Sasol SSF¹¹. Sasol, however, was initially developed as a private company with only one shareholder – the South African government.

This shows that is highly uncommon in South Africa for privately-owned companies to generate their own captive electricity, and therefore P7 is not a realistic and credible alternative.

P7: Cogeneration using waste energy (if project activity is cogeneration with waste energy, this scenario represents cogeneration with lower efficiency than the project activity)

Cogeneration with a lower efficiency than the project activity does not make this alternative financially feasible, and therefore it is not a realistic and credible alternative¹².

P9: Existing power generating equipment (used previous to implementation of project activity for captive electricity generation from a captured portion of waste gas) is either decommissioned to build new more efficient and larger capacity plant or modified or expanded (by installing new equipment), and resulting in higher efficiency, to produce and only export electricity generated from waste gas. The electricity generated by existing equipment for captive consumption is now imported from the grid.

This applies to alternatives P9, P10, and P11. There has been no existing power generating equipment that has been used previously at Namakwa Sands. Therefore, P9 to P11 are not realistic and credible alternatives for power generation in absence of the project activity.

P10: Existing power generating equipment (used previous to implementation of project activity for captive electricity generation from a captured portion of waste gas) is either decommissioned to build new more efficient and larger capacity plant or modified or expanded (by installing new

¹¹ Global Energy Decisions. (2008). *Stage 4 Report: Supply and Demand Side Resource Alternatives and Reference Case for Development of Third National Integrated Resource Plan for South Africa*. South Africa: Global Energy Decisions.

¹² Electricity study report (2009, August).



equipment), and resulting in higher efficiency, to produce electricity from waste gas (already utilized portion plus the portion flared/vented) for own consumption and for export

Please refer to P9.

P11: Existing power generating equipment is maintained and additional electricity generated by grid connected power plants

Please refer to P9.

STEP 2: Identify the fuel for the baseline choice of energy source taking into account the national and/or sectoral policies as applicable.

The baseline scenario involves the purchase of electricity from Eskom. Since the Southern African grid is predominantly coal fired, the fuel for the baseline choice of energy source is fossil fuel.

STEP 3: Step 2 and/or step 3 of the latest approved version of the “Tool for the demonstration and assessment of additionality” shall be used.

Step 3 of the ‘Tool for the demonstration and assessment of additionality’ (Version 05.2) was used to identify the most plausible baseline scenarios by eliminating non-feasible options. This has been done above. Two realistic and credible alternatives remain:

- W2: WECM is released to the atmosphere (for example after incineration) or waste heat is released to the atmosphere or waste pressure energy is not utilized;
- P6: Sourced Grid-connected power plants.

STEP 4: If more than one credible and plausible alternative scenario remain, the alternative with the lowest baseline emissions shall be considered as the most likely baseline scenario.

From step 3 above, it can be seen that the only alternatives that remain after an analysis of the investment, technological and common practice barriers, are W2 and P6. As per methodology ACM0012, baseline scenario 1 is therefore applicable:

Project Scenario: Generation of Electricity only			
Scenario	Baseline options		Description of situation
	Waste energy	Power/ heat/ mechanical energy	
1	W2	P6	Electricity is obtained from the grid.

The baseline scenario represents current practice or business as usual at Namakwa Sands.



National and Sectoral Policies and Regulations Relevant to the Project Activity

There are no policies that require Namakwa Sands to use the furnace off-gas that is currently being flared. Therefore, Namakwa Sands would continue to flare the gas if it were not for the proposed project activity. More relevant to the project activity is the Power Conservation Project (PCP), which, at the time of writing the PDD, is in the process of being developed by Eskom, in concert with Municipalities, Government, and customers.

The PCP is a demand side project aimed at stabilising the supply/demand balances in the system. According to Eskom, the details of the PCP are still being refined, but one of the criteria used in designing the PCP is to signal efficient use of electricity. Once the PCP is legislated, it will require Namakwa Sands to commit to reducing its grid electricity consumption. The relevance of the PCP, in the selection of the baseline scenario, is discussed below:

In EB 22 Annex 3, the Board differentiates between two types of national and/or sectoral policies that need to be taken into account when establishing the baseline scenario (paragraph 6). The second type is relevant to the PCP since it concerns energy efficiency:

Paragraph 6 (b): National and/or sectoral policies or regulations that give comparative advantages to less emissions-intensive technologies over more emissions-intensive technologies (e.g. public subsidies to promote the diffusion of renewable energy or to finance energy efficiency programs). These policies are E-type policies that decrease GHG emissions.

The Board then goes on to state that policies applicable under paragraph 6 (b) need not be taken into account when establishing the baseline scenario if they have been implemented since the adoption by the COP of the CDM M&P (decision 17/CP.7, 11 November 2001).

The PCP is still in development, but will, more than likely, be legislated before project implementation. However, this is after 11 November 2001 and, as such, the PCP need not be taken into account when establishing the baseline scenario for Namakwa Sands.

B.5. Description of how the anthropogenic emissions of GHG by sources are reduced below those that would have occurred in the absence of the registered CDM project activity (assessment and demonstration of additionality):
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ACM0012 requires the project proponent to determine additionality based on 'Tool for demonstration and assessment of additionality' (Version 05.2).

***Step 1: Identification of alternatives to the project activity consistent with current laws and regulations******Sub-step 1a: Define alternatives to the project activity:***

From B.4, two realistic and credible alternatives remain:

- W2: WECM is released to the atmosphere (for example after incineration) or waste heat is released to the atmosphere or waste pressure energy is not utilized;
- P6: Sourced Grid-connected power plants.

Sub-step 1b: Consistency with mandatory laws and regulations:

The above alternatives meet all legal and regulatory requirements of the host country, South Africa.

An investment analysis was performed on the proposed project activity to determine if the project is financially viable.

Step 2: Investment analysis***Sub-step 2a: Determine appropriate analysis method***

A benchmark analysis (Option III) is applied.

Sub-step 2b: Option III. Apply benchmark analysis**Financial/economic indicator**

IRR has been identified as the most suitable financial/economic indicator for this project type. This is because it is Exxaro Resources Ltd's company policy to make investment decisions based on IRR.

Selection of an appropriate benchmark

According to the 'Guidelines on the Assessment of Investment Analysis' (Version 05, EB 62 Annex 5) paragraph 14, *an internal company benchmark should only be applied in cases where (a) there is only one possible project developer and (b) should be demonstrated to have been used for similar projects with similar risks, developed by the same company.*

- (a) Exxaro Resources Ltd is the only possible project developer. This is because the project activity is located on its site, and forms an integral part of its gas system. The project activity also poses a potential health and safety risk, for which Exxaro Resources Ltd is legally liable for.



- (b) Exxaro Resources Ltd has used the same internal benchmark for similar projects with similar risks. This is elaborated below:

Exxaro Resources Ltd's Board follows a strict procedure when approving similar projects with similar risks:

- The Board minutes agenda lists the project memoranda to be authorised. The memoranda, as well as the annexure, are available during and after the Board meeting. The Board thus review the Investment Review Committee (IRC) findings before authorising projects.
- The IRC memoranda reflect the Weighted Average Cost of Capital (WACC), risk premia (technical, financial, and project phase) and hurdle rate calculations. Proper review of risk premia thus takes place.
- Project memoranda always reflect the Internal Rate of Return (IRR) and the Net Present Value (NPV).
- Board minutes and IRC adhere to the stipulation of the following official Exxaro Resources Ltd documents:
 - Exxaro Resources Ltd Corporate Governance Guiding Principles for Property.
 - Exxaro Resources Ltd Delegation of Authority.
 - WACC and Hurdle rate.

In the period between January 2008 and December 2010, Exxaro Resources Ltd approved fourteen projects that exceeded the internal company benchmark.

Since the project fulfils both criteria (a) and (b), an internal benchmark can be applied.

Sub-step 2c: Calculation and comparison of financial indicators

According to paragraph 15 of the 'Guidelines on the assessment of investment analysis' (Version 05), *the values in the table in appendix A may also be used, as a simple default option, if a company internal benchmark is used.* This project activity falls under both project categories 'Group 1' and 'Group 2' as ACM0012 is written for sectoral scopes 1 (Energy Industries) and 4 (Manufacturing Industries). Because of this, the project participant has chosen to select a conservative average benchmark between project categories 'Group 1' and 'Group 2'. Therefore, the real after tax expected return on equity in South Africa is 11.4%.

Furthermore, according to paragraph 7 of Appendix A of this guidance, if the investment analysis is carried out in nominal terms, project participants can convert the real term expected return on equity to nominal values by adding the inflation rate. Therefore, the nominal after tax expected return on equity in South Africa is calculated as 15.9%.

The nominal after-tax project IRR is -8.6%. This IRR is not limited to proposed crediting period, but rather reflects the period of expected operation of the project activity (16 years). The IRR calculation



includes the cost of major maintenance and rehabilitation, as these costs are expected to be incurred during the period of expected operation.

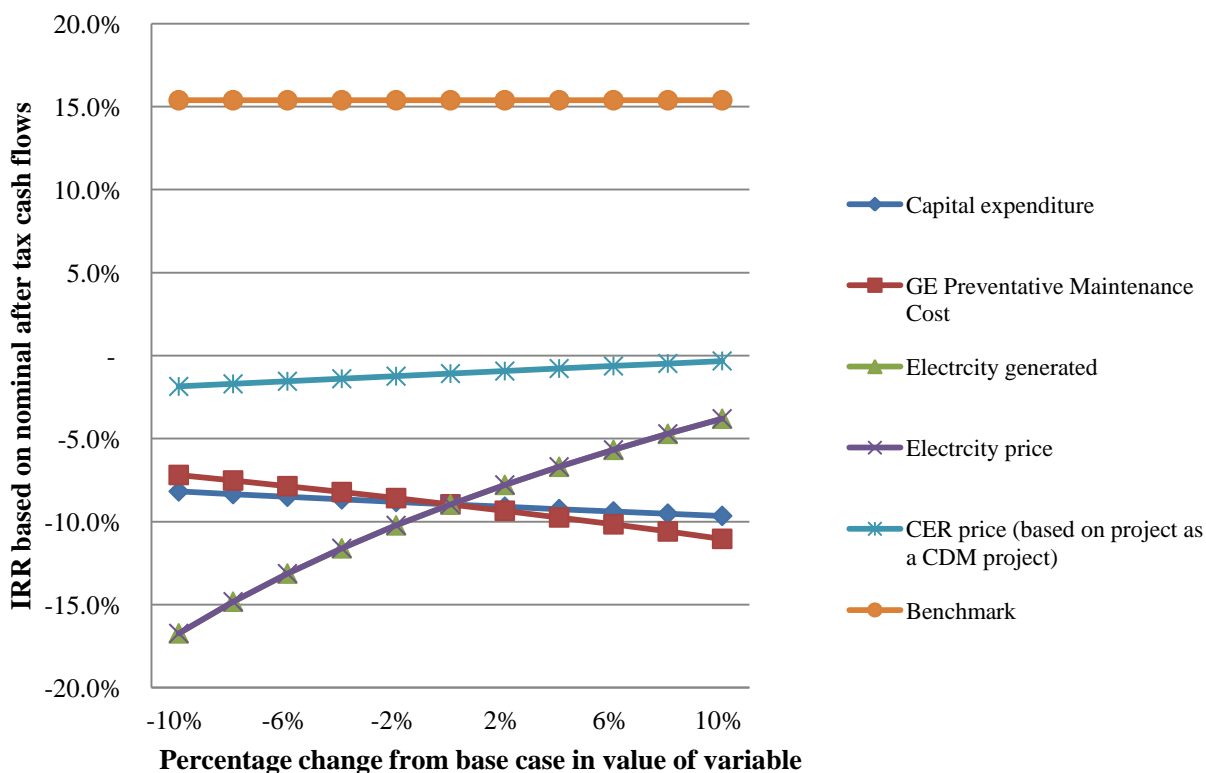
The CDM project activity has a less favourable IRR than the benchmark (-8.6% as opposed to 15.9%). For this reason, the project cannot be considered as financially attractive in the absence of the CDM.

Sub-step 2d: Sensitivity analysis

The aim of the sensitivity analysis is to determine the likelihood of the occurrence of a scenario other than the scenario presented. The individual variables, including the initial investment, that constitute more than 20% of the total project cost and project revenues are:

- Capital expenditure;
- GE Jenbacher engine preventative maintenance cost;
- Electricity generated;
- Electricity price;
- CER price.

The sensitivities on these parameters is represented graphically below.





None of the individual variables breach the benchmark IRR of 15.9% within the $\pm 10\%$ range. The results of the sensitivity analysis show that the conclusion regarding the financial/economic attractiveness (made in sub-set 2c above) is robust to reasonable variations in the critical assumptions.

Step 4: Common practice analysis

Sub-step 4a: Analyze other activities similar to the proposed project activity:

Common practice can be demonstrated in accordance with EB 63 Annex 12 ‘Guidelines on Common Practice’ (Version 01.1). A stepwise approach is used:

Step 1: Calculate applicable output range as $\pm 50\%$ of the design output or capacity of the proposed project activity

The design capacity of the proposed project activity is 13.6 MW. Therefore, the applicable output range used for this analysis is 6.8 – 20.4 MW.

Step 2: Identify all plants that deliver the same output or capacity

In this analysis, the applicable geographical area is South Africa. According to the guidelines, a measure is a broad class of greenhouse gas emission reduction activities possessing common features. For this analysis, the measure is the use of ilmenite furnace off gas as a fuel to generate energy.

Ilmenite smelting is currently practised in only three locations in South Africa: Richards Bay Minerals, Namakwa Sands and KZN Sands¹³. For this reason, these three smelters are the only plants that are currently generating ilmenite furnace off gas in South Africa.

The Richards Bay Minerals project is currently in CDM validation¹⁴ and has not started commercial operation yet. For this reason (and in accordance with the guidelines), it is excluded from N_{all} .

KZN Sands is owned by Exxaro Resources Ltd and currently flares its furnace off gas. This smelter is not implementing a waste energy recovery project. This project is therefore also excluded from N_{all} .

For this reason, $N_{all} = 0$.

Step 3: Identify plants that apply different technologies

Since N_{all} has been identified as being equal to zero, N_{diff} is also equal to zero.

¹³ Pistorius, P. (2008). Ilmenite smelting: the basics. *The Journal of The Southern African Institute of Mining and Metallurgy*, 35-43.

¹⁴ <http://cdm.unfccc.int/Projects/Validation/index.html>



Step 4: Calculate the factor F

The factor F is used to represent the share of plants using technology similar to the technology used in the proposed project activity. The equation to calculate F is given below:

$$F = 1 - \frac{N_{diff}}{N_{all}}$$

Since $N_{all} = N_{diff} = 0$, the factor F does not compute. For this reason, the analysis does not show a lack of common practice however; it has been proven that there are no ilmenite smelters in South Africa that are currently implementing a similar project in the absence of the Clean Development Mechanism.

Furthermore, the analysis cannot be used to prove a lack of common practice in this project activity as N_{all} is less than 3, and therefore, $N_{all} - N_{diff}$ can never be greater than 3.

Nevertheless, the proposed project activity has already been proven to additional through an investment analysis, as shown in Step 2.

Sub-step 4b: Discuss any similar Options that are occurring:

In South Africa, there are no ilmenite smelters that are currently implementing a similar project in the absence of the CDM. The project activity aims to be the first registered South African CDM project to generate electricity from waste gas at an ilmenite smelter. As demonstrated in the investment analysis above, the project activity is additional.

Notice of prior consideration

The milestones in the project development are provided in the timeline below:

Date	Milestone
08/03/2006	Proposal for an evaluation study into the use of furnace off-gas at Namakwa Sands.
24/07/2006	Boiler quotation from Babcock Africa Services (Pty) Ltd.
07/08/2006	Engine quotation from GE Jenbacher.
31/08/2006	Promethium Carbon (Pty) Ltd completes prefeasibility study on proposed project activity.
19/01/2007	Exxaro Resources Ltd acquires the Namakwa Sands business
16/01/2008	Eskom Transmission feasibility quotation for connection of 9 x 2.097 MVA generators at Namakwa Sands Project.
04/03/2008	South African DNA letter of no objection for the Namakwa waste gas utilisation project.
11/04/2008	Memorandum of Understanding between Exxaro Coal (Pty) Ltd (a subsidiary of Exxaro Resources Ltd), Promethium Carbon (Pty) Ltd, and Group Five Energy (Pty) Ltd.
25/06/2008	Steering committee shows prior consideration of the CDM.



22/10/2008	Application notice for a basic assessment for a cogeneration plant at the Namakwa Sands Smelter, Saldanha Bay.
06/11/2008	A Background Information Document (BID) is released for a 30-day public comment period in order to provide interested and affected parties an opportunity to comment on the proposed project.
20/11/2008	An open day is held at the Skilpadsaal in Vredenburg, which provided the public with an opportunity to get more information regarding the proposed project.
11/06/2009	Request submitted to the Department of Environmental Affairs & Development Planning (DEA&DP) for an extension to the submission timeframe for the final basic assessment report.
03/03/2010	Request submitted to the Department of Environmental Affairs & Development Planning (DEA&DP) for a further six month extension to the submission timeframe for the final basic assessment report.
31/08/2010	Notice of prior consideration submitted to the UNFCCC and South African DNA.
11/11/2010	PDD completed by Promethium Carbon (Pty) Ltd.
18/11/2010	PDD published for Global Stakeholder Participation on UNFCCC website.

B.6. Emission reductions:

B.6.1. Explanation of methodological choices:

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The emission reductions were calculated in accordance with ACM0012 version 03.2: ‘Consolidated baseline methodology for GHG emission reductions from waste energy projects’, Version 03.2, Sectoral Scopes 01 and 04, EB 51.

Baseline Emissions

The baseline emissions were determined as follows:

$$BE_y = BE_{EN,y} + BE_{flst,y} \quad (1)$$

Where:

BE_y The total baseline emissions during the year y in tons of CO_2

$BE_{EN,y}$ The baseline emissions from energy generated by project activity during the year y in tons of CO_2

$BE_{flst,y}$ Baseline emissions from generation of steam, if any, using fossil fuel, that would have been used for flaring the waste gas in absence of the project activity (tCO_2e per year), calculated as per Equation 1c. This is relevant for those project activities where in the baseline steam is used to flare the waste gas

But, $BE_{flst,y} = 0$, since no additional fossil fuel is used in the baseline for waste furnace off-gas combustion because the gas is combustible. Therefore, equation (1) simplifies to:



$$BE_y = BE_{EN,y}$$

The calculation of baseline emissions ($BE_{EN,y}$) depends on the identified baseline scenario. Scenario 1 was identified as applicable to the proposed project activity as electricity is obtained from the grid in the baseline. Therefore, the baseline emissions from the energy generated by the project activity ($BE_{EN,y}$) were determined as follows:

$$BE_{EN,y} = BE_{Elec,y} + BE_{Ther,y} \quad (1a)$$

$BE_{Elec,y}$ Baseline emissions from electricity during the year y in tons of CO_2

$BE_{Ther,y}$ Baseline emissions from thermal energy (due to heat generation by element process) during the year y in tons of CO_2

(a.i) Baseline emissions from electricity ($BE_{Elec,y}$) Type-1 activities:

Case-1: Waste energy is used to generate electricity

The baseline emissions from electricity that is displaced by the project activity ($BE_{Elec,y}$) were determined as follows:

$$BE_{Elec,y} = f_{cap} \times f_{wcm} \times \sum_j \sum_i (EG_{i,j,y} \times EF_{Elec,i,j,y}) \quad (1a-1)$$

Where:

$BE_{Elec,y}$ Baseline emissions due to displacement of electricity during the year y in tons of CO_2

$EG_{i,j,y}$ The quantity of electricity supplied to the recipient j by generator, that in the absence of the project activity would have been sourced from i^{th} source (i can be either grid or identified source) during the year y in MWh, and

$EF_{Elec,i,j,y}$ The CO_2 emission factor for the electricity source i ($i=gr$ (grid) or $i=is$ (identified source)), displaced due to the project activity, during the year y in tons CO_2 /MWh. The calculations for the CO_2 emission factor of the Southern African Power Pool are provided below.

f_{wcm} Fraction of total electricity generated by the project activity using waste energy. This fraction is 1 if the electricity generation is purely from use of waste energy.

f_{cap} Energy that would have been produced in project year y using waste energy generated in base year expressed as a fraction of total energy produced using waste source in year y . The ratio is 1 if the waste energy generated in project year y is same or less than that generated in base year. The value is estimated using equations (1f), or (1f-1) or (1f-2), or (1g), (1g-1) or (1h).



Calculation of $EF_{Elec,i,j,y}$:

The project activity will displace grid electricity.

The emission factor for the grid electricity was calculated in accordance with the latest approved version of the “Tool for calculation of emission factor for electricity systems,” Version 02.2.1. The steps applied to determine the emission factor for the grid were as follows:

Step 1: Identify the relevant electricity systems

This tool will serve project activities that prospect displace grid electricity in countries that form part of the Southern African Power pool.

The **project electricity system** is defined by the spatial extent of the power plants that are physically connected through transmission and distribution lines to the project activity and that can be displaced without significant transmission constraints.

Similarly, a **connected electricity system**, e.g. national or international, is defined as an electricity system that is connected by transmission lines to the project electricity system. Power plants within the connected electricity system can be dispatched without significant transmission constraints, but transmission to the project electricity system has significant transmission constraints.

None of the DNAs of Southern African countries have published delineations of their project electricity systems or connected electricity systems. There is however information available on the countries that is part of the SAPP grid¹⁵; generated and exported electricity¹⁶, as well as connected transmission lines between countries and the maximum ratings¹⁷.

The countries that are *physically connected* in the SAPP are (excluding countries that are part of SAPP, but not connected) (connected utilities indicated in brackets):

- Namibia (NamPower);
- South Africa (Eskom and non-Eskom stations);
- Zimbabwe (ZESA);
- Zambia (ZESCO);
- Mozambique (EDM);
- Botswana (BPC);
- Democratic Republic of Congo (SNEL);
- Lesotho (LEC);

¹⁵ The Southern African Power Pool, 2007, *SAPP Grid*,
<http://www.sapp.co.zw/viewinfo.cfm?id=7&linkid=12&siteid=1>

¹⁶ The Southern African Power Pool, *Annual Reports*,
<http://www.sapp.co.zw/viewinfo.cfm?id=71&linkid=2&siteid=1>

¹⁷ The Southern African Power Pool, 2007, *Interconnector limits*,
<http://www.sapp.co.zw/viewinfo.cfm?id=74&linkid=12&siteid=1>

- Swaziland (SEB).



Figure 6: The SAPP Grid.



The Caprivi link is an interconnector (not indicated in Figure 6) that is currently under construction between Zimbabwe and Namibia. It will supply 150 megawatts (MW) of electricity from Hwange power station to Namibia. The Caprivi Link is part of the ZIZABONA project and the power line from Hwange in Zimbabwe to Livingstone in Zambia is expected to be completed by December 2010¹⁸. This link will not be considered in calculations.

To determine which of the connected utilities are part of the **project electricity system** and which are **connected electricity systems**, the existence of significant transmission constraints between utilities has to be determined.

The existence of significant transmission constraints from the connected electricity system to the project electricity system are determined by the following criteria:

- In case of electricity systems with spot markets for electricity: there are differences in electricity prices (without transmission and distribution costs) of more than 5 percent between the systems during 60 percent or more of the hours of the year
- The transmission line operates at 90% or more of its rated capacity during 90% percent or more of the hours of the year.

Spot markets are not applicable for this electricity system. The SAPP does have a Short Term Energy Market (STEM). STEM is designed to be a day-ahead market and compliments the bilateral market through the provision of another technique for the pricing of electrical energy. A day-ahead market is a physical market where prices and amounts are based on supply and demand. SAPP said in 2004: “*The ambition of SAPP is to establish a regional spot market where electricity would be traded in real time and provide the necessary basis for the development of subsequent financial markets*”¹⁹. This has not been implemented to date as the STEM “Book of Rules” currently in use is still the 2003 version²⁰

A 3-year average (2007-2009 financial years; 1 April – 31 March) for each utility’s electricity combined imports and exports are obtained from the SAPP annual reports. This is used, together with 90% of the rated interconnector limits (illustrated in Figure 7) to calculate the percentage of hours in a year operated at 90% of rated capacity.

It was found that there is no significant transmission constraints between any of the connected SAPP countries, and thus no **connected electricity systems**. Therefore, all the suppliers listed above comprise the **project electricity system**, from which the project activity sources electricity.

¹⁸ Informante, *Simasiku on Caprivi link project and Hwange*, Administrator, 14 January 2010, http://www.informante.web.na/index.php?option=com_content&task=view&id=5570&Itemid=108&PHPSESSID=b4dcfee218fc205d8efdeb7968b06910

¹⁹ Dr. L. Musaba, P. Naidoo, W. Balet and A. Chikova, Developing a competitive market for regional electricity cross border trading: The case for the Southern African Power Pool, <http://www.sapp.co.zw/documents/P12%20-%20SAPP%20Publication%20for%20IEE%20-%20JAN%202004.pdf> as accessed on 2 June 2010

²⁰ <http://www.sapp.co.zw/docs/STEM%20Book%20of%20Rules%20-%20%20APRIL%202003.pdf> as accessed on 2 June 2010

**Step 2: Chose whether to include off-grid power plants in the project electricity system (optional)**

The grid emission factor is calculated from only grid power plants (Option I). Off-grid power plants are not included in the calculations.

Step 3: Select a method to determine the operating margin (OM)

The OM is calculated using the simple OM method (Option (a)). The simple OM method can be used provided that the low-cost/must-run resources constitute less than 50% of the total grid generation in average of the five most recent years.

The total generated electricity for the different utilities were obtained from the SAPP annual reports, but data for the electricity resources and generation capacities were not readily available in the public domain. The source and type of data that were used to establish the low-cost/must-run resources of each utility can be found in Table 2 (actual values used are shown in Table 4).

Table 2: Utility power generation resources

Country (Utility)	Data description	Source
Namibia (NamPower)	General fractions for different electricity production resources	Developing Renewables, <i>Country Energy Information, Namibia</i> , 2006, http://www.energyrecipes.org/reports/genericData/Africa/061129%20RECIPES%20country%20info%20Namibia.pdf
South Africa (Eskom)	Actual generation (GWh) for 2006-2008.	Eskom Holdings Limited, 2009, <i>Eskom Annual Report 2009</i> , http://www.eskom.co.za/annreport09/
Zimbabwe (ZESA)	Generation capacity (MW) of different resources.	Stuart Doran, 2009, <i>Zimbabwe's economy</i> , http://www.thebrenthurstfoundation.org/Files/Brenthurst_Commisioned_Reports/BD0908-Zimbabwe.pdf
Zambia (ZESCO)	General fractions for different electricity production resources	ZESCO official website, http://www.zesco.co.zm/index.php?option=com_content&task=view&id=1&Itemid=
Mozambique (EDM)	Actual generation (GWh) for 2000-2004 (average taken).	<i>Brief analysis of energy sector in Mozambique</i> , EDM Annual Statistical Reports 2000-2004, http://www.moenergy.com/articles/MozambiqueEnergyOverview.pdf
Botswana (BPC)	General fractions for different electricity production resources	Nationmaster website, http://www.nationmaster.com/country/bc-botswana/ene-energy
Democratic Republic of Congo (SNEL)	General fractions for different electricity production resources	Geni website and SAPP, http://www.geni.org/globalenergy/library/national_energy_grid/democratic-republic-of-the-congo/demrepubliccongonationalelectricitygrid.shtml



Lesotho (LEC)	General fractions for different electricity production resources	The Southern African Power Pool, 2007, <i>SAPP Grid</i> , http://www.sapp.co.zw/viewinfo.cfm?id=7&linkid12&siteid=1
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The average percentage of low-cost/must-run resources, for the entire SAPP grid, amount to 15.79% of the total grid generation. Therefore, Option (a) is applicable to the SAPP grid emission factor calculations.

In terms of data vintages, the *ex ante* option were chosen to calculate the simple OM. In this option a 3 year generation-weighted average are used for the grid power plants. Using this option also means that the emission factor is determined only once at the validation stage, thus no monitoring and recalculation is required during the crediting period.

The data used in OM calculations are for the 3 year period of 1 April 2006 – 31 March 2009 (SAPP financial year runs from 1 April – 31 March). This is the latest available data.

Step 4: Calculate the operating margin emission factor according to the selected method

The simple OM emission factor ($EF_{grid,OMsimple,y}$) is calculated as the generation-weighted average CO₂ emissions per unit net electricity generation (tCO₂/MWh) of all generating power plants serving the system, not including low-cost/must-run power plants/units. Hence, the hydro and nuclear power plants are excluded from the calculation of the OM.

Option B is used for calculating the simple OM. The calculations in this option are based on the total net electricity generation of all power plants serving the system and the fuel types and fuel consumption of the project electricity system. Option B is used seeing that:

- The necessary data for Option A (electricity generation and emission factor for each power unit) is not available; and
- Only nuclear and renewable power generation are considered as low-cost/must-run power sources and the quantity of electricity supplied to the grid by these sources is know; and
- Off-grid power plants are not included in the calculation.

In addition to data and sources already provided in this report, Table 3 depicts data descriptions and sources that were used in the calculation of the simple OM (actual values used can be found in Tables 4 and 5).

Table 3: Other data used in calculations

Country (Utility)	Data description	Source
Namibia (NamPower)	Fuel efficiencies for Paratus and Van Eck power stations.	Republikein, <i>Namibia's power is in your hands; Use it wisely</i> , April 2008, www.republikein.com.na/fileadmin/pdf/2008/nampower.pdf



South Africa (Eskom)	Coal-fired stations fuel efficiency (average for all stations).	Eskom Holdings Limited, 2009, <i>Eskom Annual Report 2009</i> , http://www.eskom.co.za/annreport09/
South Africa (Eskom)	Gas turbine stations fuel efficiency (average for all stations).	Eskom Website (data used for 2005; latest available), http://www.eskom.co.za/live/content.php?Item_ID=4226&Revision=en%2F0
Zimbabwe (ZESA)	Fuel efficiency of Hwange coal-fired station.	UNFCCC website (data used from previous project), http://unfccc.int/kyoto_mechanisms/ajj/activities_implemented_jointly/items/1886.php
Zimbabwe (ZESA)	Net calorific value (NCV) and emission factor (EF) for Zimbabwean coal.	UNFCCC website (data used from previous project), http://unfccc.int/kyoto_mechanisms/ajj/activities_implemented_jointly/items/1886.php
General	NCV and EF for sub-bituminous coal and heavy fuel oil (HFO) (residual fuel oil values used from IPCC).	<i>2006 IPCC Guidelines for National Greenhouse Gas Inventories</i>

Equation 7 (in the methodological tool) is used to calculate the average OM:

$$EF_{grid,OMsimple,y} = \frac{\sum_i (FC_{i,y} \times NCV_{i,y} \times EF_{CO_2,i,y})}{EG_y} \quad (\text{GEF Tool}^{21} \text{ Eq. 7})$$

Where:

- $EF_{grid,OMsimple,y}$ = CO₂ emission factor of power unit *m* in year *y* (tCO₂/MWh)
- $FC_{i,y}$ = Amount of fossil fuel type *i* consumed by power plant/unit *m* in year *y* (mass or volume unit)
- $NCV_{i,y}$ = Net calorific value (energy content) fossil fuel type *i* in year *y* (GJ/mass or volume)
- $EF_{CO_2,i,y}$ = CO₂ emission factor of fossil fuel type *i* in year *y* (tCO₂/GJ)
- EG_y = Net electricity generated and delivered to the grid by all power sources serving the system, not including low-cost/must-run power plants/units, in year *y* (MWh)
- i* = All fossil fuel types combusted in power sources in the project electricity system in year *y*

²¹ UNFCCC methodological tool for the grid emission factor (GEF), “Tool for calculation of emission factor for electricity systems,” Version 02.



y = The relevant year as per data vintage chosen in Step 3.

The constants used in calculations appear in Table 3, while all the values and final calculated operating margin emission factor can be seen in Table 4.

Table 4: Constants used in calculations (refer to Table 3 for references)

Constants		
NCV _{sub-bituminous coal}	18.9	GJ/T
NCV _{HFO (Residual Fuel Oil)}	40.4	GJ/T
NCV _{kerosene}	43.8	GJ/T
EF _{CO₂, sub-bituminous coal}	0.0961	tCO ₂ /GJ
EF _{CO₂, HFO (Residual Fuel Oil)}	0.0774	tCO ₂ /GJ
EF _{CO₂, kerosene}	0.0719	tCO ₂ /GJ
Density _{HFO (Residual Fuel Oil)}	930	kg/m ³
NCV _{coal, Zimbabwean}	25.75	GJ/T
EF _{CO₂, coal, Zimbabwean}	0.0946	tCO ₂ /GJ

Table 5: Electricity generation, fuel consumption, and calculated OM

Supplier	3 yr avg. (GWh)	Fuel Efficiency (T/GWh)	Fuel Consumed (T)	EF _{grid, OMsimple} (tCO ₂ /MWh)
Namibia (NamPower)	1,584.67	-	-	1.04
Hydro (Ruacana)	1,537.13	-	-	
Heavy Fuel Oil (Paratus)	47.54	260.40	12,379.42	
Coal (van Eck)	-	570.00	-	
South Africa (Eskom)	230,011.67	-	-	
Coal Fired	213,459.10	552.70	117,979,150.89	
Hydroelectric	1,361.91	-	-	
Pumped-storage	1,935.18	-	-	
Gas turbine (kerosene)	404.07	365.50	147,688.57	
Nuclear power	7,522.33	-	-	
Zimbabwe (ZESA)	7,781.00	-	-	
Coal (Hwange)	1,897.80	505.00	958,391.46	
Hydro (Kariba)	5,883.20	-	-	
Zambia (ZESCO)	9,771.00	-	-	
Hydro	9,761.23	-	-	



Supplier	3 yr avg. (GWh)	Fuel Efficiency (T/GWh)	Fuel Consumed (T)	EF _{grid,OMsimple} (tCO2/MWh)
Diesel	9.77	No Data	No Data	
Mozambique (EDM)	261.67	-	-	
Hydro	223.90	-	-	
Diesel	37.77	No Data	No Data	
Botswana (BPC)	728.00	-	-	
Coal Fired	696.84	No Data	No Data	
Oil	31.16	No Data	No Data	
DRC (SNEL)	7,345.33	-	-	
Hydro	7,345.33	-	-	
Lesotho (LEC)	479.33	-	-	
Hydro	479.33	-	-	
Swaziland (SEB)	137.30	-	-	

Step 5: Calculate the build margin emission factor

The build margin must consist of either:

- The set of five power plants most recently built; or
- The set of power capacity additions in the electricity system that comprise 20% of the system generation and that have been most recently built.

The set of power plants that comprise the larger annual generation should be used.

Only data from NamPower, Eskom, and ZESA are available in the public domain, therefore Option (a) is used.

In order to determine the vintage of data, one of the following options must be selected:

Option 1: For the first crediting period, calculate the build margin emission factor *ex ante* based on the most recent information available at the time of CDM-PDD submission to the DOE for validation.

Option 2: For the first crediting period, the build margin emission factor shall be updated annually, *ex post*, including those units built up to the year of registration of the project activity.

Option 1 is used for this project due to the lack consistent data from the same vintage for the NamPower, Eskom, and ZESA power plants.



The commissioning dates for the Eskom and power plants appear in on the Eskom website²². NamPower and ZESA power plants are listed in Table 6 with their commissioning dates.

Table 6: Supplementary commissioning dates

Power Plant	Commissioning Date	Reference
Ruacana	1977	NamPower, http://www.nampower.com.na/pages/ruacana.asp
Paratus	1976	NamPower, http://www.nampower.com.na/pages/paratus.asp
Van Eck	1979	NamPower, http://www.nampower.com.na/pages/van-eck.asp
Hwange	1984	Power plants around the world, <i>Coal-fired power plants in Africa</i> , November 2009, http://www.industcards.com/st-coal-africa.htm

The five most recently built power plants and their emission factors appear in Table 7. Generation and fuel consumption data for Eskom power stations were obtained from the Eskom website (for the financial year ending 31 March 2010²³). This is the latest available data.

Table 7: Power plants included in the BM

Station	On-Line Year	Generation (MWh)	Fuel Consumption (Tons)	EF _{EL,m,y}
Kendal (Eskom)	1988	23,307,031.00	13,866,514.00	1.08
Lethabo (Eskom)	1985	25,522,698.00	18,170,227.00	1.29
Majuba (Eskom)	1996	22,340,081.00	12,261,833.00	1.00
Matimba (Eskom)	1987	27,964,141.00	14,637,481.00	0.95
Tuktuka (Eskom)	1985	19,847,894.00	10,602,839.00	0.97

The build margin emissions factor is the generation-weighted average emission factor (tCO₂/MWh) of all power units m during the most recent year y for which power generation data is available, calculated as follows:

$$EF_{grid,BM,y} = \frac{\sum_m EG_{m,y} \cdot EF_{EL,m,y}}{\sum_m EG_{m,y}} \quad \text{(GEF Tool Eq. 13)}$$

Where:

EF_{grid,BM,y} Build margin CO₂ emission factor in year y (tCO₂/MWh)

²² Eskom Holdings Limited, 2010, *CDM Calculations, General Information*, http://www.eskom.co.za/live/content.php?Item_ID=4226&Revision=en/0 [Accessed 1 November 2010]

²³ Eskom Holdings Limited, 2010, *CDM Calculations, General Information*, http://www.eskom.co.za/live/content.php?Item_ID=4226&Revision=en/0 [Accessed 1 November 2010]



$EG_{m,y}$	Net quantity of electricity generated and delivered to the grid by power unit m in year y (MWh)
$EF_{EL,m,y}$	CO ₂ emission factor of power unit m in year y (tCO ₂ /GJ)
M	Power units included in the build margin
y	The relevant year as per data vintage chosen in Step 3.

The CO₂ emission factor of each power unit m ($EF_{EL,m,y}$) should be determined as per the guidance in Step 3 (a) for the simple OM, using option A1 using for y the most recent historical year for which power generation data is available, and using for m the power units included in the build margin.

If for a power unit m data on fuel consumption and electricity generation is available the emission factor ($EF_{EL,m,y}$) should be determined as follows:

$$EF_{EL,m,y} = \frac{\sum_i FC_{i,m,y} \cdot NCV_{i,y} \cdot EF_{CO_2,i,y}}{\sum_m EG_{m,y}} \quad \text{(GEF Tool Eq. 2)}$$

Where:

$EF_{EL,m,y}$	CO ₂ emission factor of power unit m in year y (tCO ₂ /MWh)
$FC_{i,m,y}$	Amount of fossil fuel type i consumed by power unit m in year y (mass or volume unit)
$NCV_{i,y}$	Net calorific value (energy content) fossil fuel type i in year y (GJ/mass or volume)
$EF_{CO_2,i,y}$	CO ₂ emission factor of fossil fuel type i in year y (tCO ₂ /GJ)
$EG_{m,y}$	Net electricity generated and delivered to the grid by power unit m in year y (MWh)
m	All power plants/units serving the grid in year y except low-cost/must-run power plants/units
i	All fossil fuel types combusted in power plant/unit m in year y
y	The relevant year as per data vintage chosen in Step 3.

Emission factors for individual power plants appear in Table 7.

Using equation 13, the BM is calculated as **1.06** tCO₂e/MWh.

Step 7: Calculate the combined margin (CM) emission factor

The combined margin factor is calculated as follows:

$$EF_{grid,CM,y} = EF_{grid,OM,y} \times W_{OM} + EF_{grid,BM,y} \times W_{BM} \quad \text{(GEF Tool Eq. 14)}$$

Where:



$EF_{grid,BM,y}$	Build Margin CO ₂ emission factor in year y (tCO ₂ /MWh)
$EF_{grid,OM,y}$	Operating margin CO ₂ emission factor in year y (tCO ₂ /MWh)
w_{OM}	Weighting of operating margin emissions factor (%)
w_{BM}	Weighting of build margin emissions factor (%)

The emission factors for the operating margin, the build margin, and the final combined margin appear in Table 8.

Table 28: CM emission factor

$EF_{grid,OM,y}$	1.01
$EF_{grid,BM,y}$	1.06
w_{OM}	0.5
w_{BM}	0.5
$EF_{grid,CM,y}$	1.04

$f_{wcm} = 1$, since the electricity generation is purely from the use of waste gas.

ACM0012 requires that the baseline emissions should be capped in order to introduce an element of conservativeness. Three methods of capping are available to project developers. The capping of the baseline emissions for this project case will be done by applying Method 2. Using this method, equation (1g) was used to estimate f_{cap} . $f_{cap} = 1$ if the waste energy generated in the project year is the same as or less than that generated in the base year.

$$f_{cap} = \frac{Q_{WCM,BL}}{Q_{WCM,y}} \quad (1g)$$

$$Q_{WCM,BL} = Q_{BL,product} \times q_{WCM,product} \quad (1g-1)$$

Where:

$Q_{WCM,BL}$	Quantity of waste energy generated prior to the start of the project activity estimated using Equation 1g-1.
$Q_{BL,product}$	Production associated with the relevant waste energy generation as it occurs in the baseline scenario.
$q_{WCM,product}$	Amount of waste energy per unit of product generated by the process (that generates waste energy) in the industrial facility.



Project Emissions

Project emissions are calculated as per equation (2) below:

$$PE_y = PE_{AF,y} + PE_{EL,y} + PE_{EL,import,y} \quad (2)$$

Where:

PE_y	Project emissions due to project activity
$PE_{AF,y}$	Project activity emissions from on-site consumption of fossil fuels by the cogeneration plant(s), in case they are used as supplementary fuels, due to non-availability of waste gas to the project activity or due to any other reason.
$PE_{EL,y}$	Project activity emissions from on-site consumption of electricity for gas cleaning and conditioning equipment
$PE_{EL,import,y}$	Project activity emissions from import of electricity replacing captive electricity generated in the absence of the project activity for Type-2 project activities

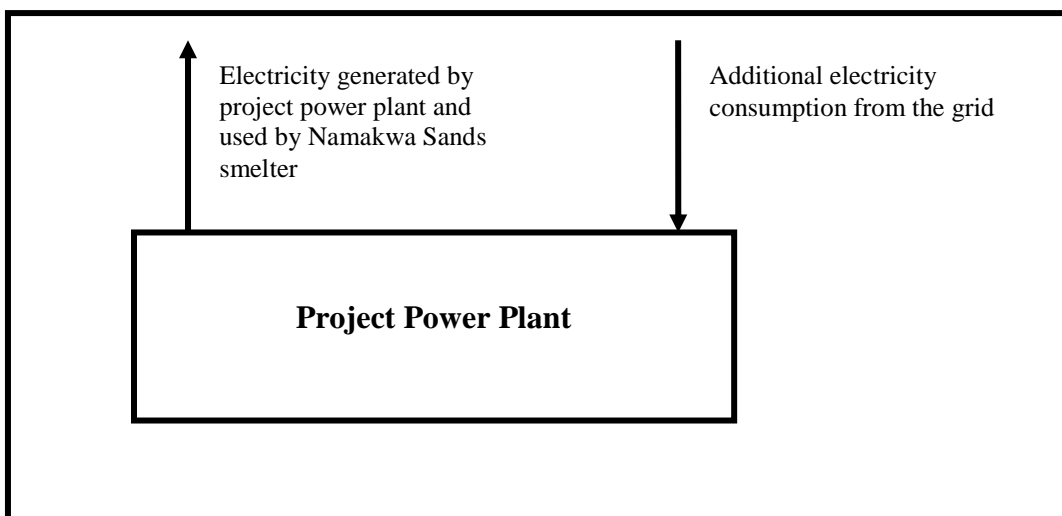
The proposed project is a Type-1 project and, therefore, the project activity emissions from import of electricity replacing captive electricity are not applicable. Furthermore, no auxiliary fuel is used when combusting the waste furnace off-gas. Therefore:

$$PE_{AF,y} = PE_{EL,import,y} = 0$$

Therefore, equation (2) simplifies to:

$$PE_y = PE_{EL,y}$$

There will be electricity used in the additional gas cleaning and conditioning. Project emissions due to electricity consumption ($PE_{EL,y}$) were calculated by multiplying the CO₂ emission factor for electricity ($EF_{CO_2,EL,y}$) by the total amount of electricity used as a result of the project activity ($EC_{PJ,y}$). During plant maintenance, the source of electricity for the proposed project plant will be the grid.



Plant maintenance situation

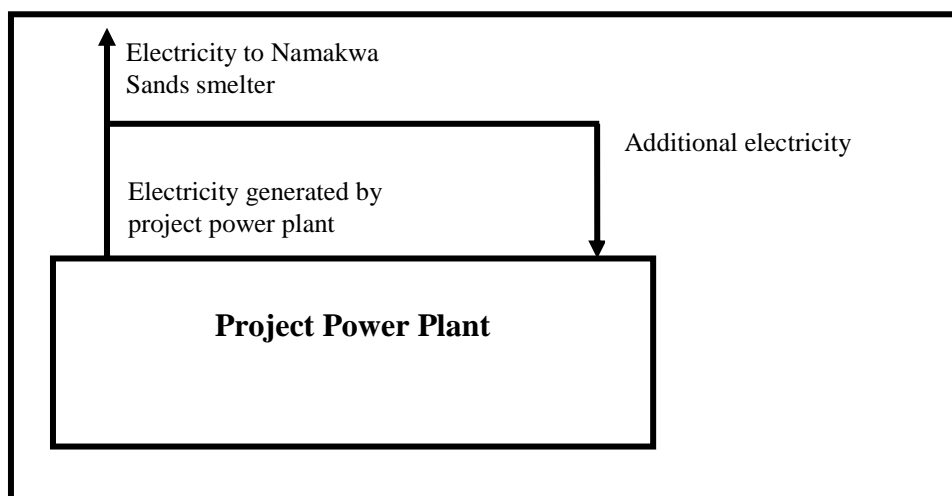
The calculation is presented below:

$$PE_{EL,y} = EC_{PJ,y} \times EF_{CO_2,EL,y} \quad (2b)$$

Where:

$PE_{EL,y}$	Project emissions from consumption of electricity in gas cleaning equipment of project activity (tCO ₂ /yr)
$EC_{PJ,y}$	Additional electricity consumed in year y as a result of the implementation of the project activity (MWh)
$EF_{CO_2,EL,y}$	CO ₂ emission factor for electricity consumed by the project activity in year y (tCO ₂ /MWh)

During operation, the source of the electricity will be the proposed project plant. A small portion of the electricity produced by the project activity will be used to supply the equipment with electricity. This will decrease the amount of electricity supplied to the Namakwa Sands smelter.



Operation situation

In the case above, the baseline emissions change since the net amount of electricity supplied to Namakwa Sands smelter decreases. The project emissions also change as the electricity required for additional gas cleaning and conditioning is sourced from the electricity generated by the project activity and not from the grid. Hence, the project emissions from electricity consumption become:

$$PE_{EL,y} = EC_{PJ,y} \times EF_{CO_2,EL,y} \quad (2b)$$

Where:

- $PE_{EL,y}$ Project emissions from consumption of electricity in gas cleaning equipment of project activity (tCO₂/yr)
- $EC_{PJ,y}$ Additional electricity consumed in year y as a result of the implementation of the project activity (MWh)
- $EF_{CO_2,EL,y}$ CO₂ emission factor for electricity consumed by the project activity in year y (t CO₂/MWh)

The electricity is consumed from the grid and therefore the CO₂ emission factor for the electricity consumed is calculated using version 02.2.1 of the 'Tool to calculate the emission factor for an electricity system'.

Leakage

No leakage is applicable under this methodology.

**Emission Reductions**

Emission reductions due to the project activity during the year y were calculated as follows:

$$ER_y = BE_y - PE_y \quad (3)$$

Where:

- ER_y Total emissions reductions during the year y in tons of CO₂
 PE_y Emissions from the project activity during the year y in tons of CO₂
 BE_y Baseline emissions for the project activity during the year y in tons of CO₂

B.6.2. Data and parameters that are available at validation:

Data / Parameter:	$EF_{Elec,gr,j,y}$
Data unit:	tCO ₂ / MWh
Description:	CO ₂ emission factor for grid electricity displaced by the project activity during year y
Source of data used:	The combined margin emission factor, determined according to version 02.2.1 of the 'Tool to calculate emission factor for an electricity system'
Value applied:	1.04
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per applied tool, this value will be calculated ex-ante. The calculations for the tool will be made available during validation.
Any comment:	

Data / Parameter:	$EF_{CO_2,EL,y}$
Data unit:	tCO ₂ / MWh
Description:	CO ₂ emission factor for electricity consumed by the project activity in year y (electricity is sourced from the grid).
Source of data used:	The combined margin emission factor, determined according to version 02.2.1 of the 'Tool to calculate emission factor for an electricity system'
Value applied:	1.04
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per applied tool, this value will be calculated ex-ante. The calculations for the tool will be made available during validation.
Any comment:	

Data / Parameter:	$Q_{WCM,BL}$
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Data unit:	Nm ³ /year
Description:	Average quantity of waste energy released in the atmosphere by WECM in three years prior to the start of the project activity.
Source of data used:	Plant measurement records.
Value applied:	Average 2008 – 2010: 93,160,700
Justification of the choice of data or description of measurement methods and procedures actually applied :	Calculated from energy balance. Refer to Annex 3.
Any comment:	

Data / Parameter:	$Q_{OE,BL}$
Data unit:	MWh
Description:	Output energy that can theoretically be produced by the project activity waste heat recovery equipment.
Source of data used:	Manufacturer's specifications and project design.
Value applied:	2013: 104,121 2014: 118,966 2015: 118,966 2016: 118,966 2017: 118,966 2018: 118,966 2019: 118,966 2020: 118,996 2021: 118,966 2022: 118,966
Justification of the choice of data or description of measurement methods and procedures actually applied :	As per methodology ACM0012, manufacturer's specifications can be used to estimate the theoretical energy.
Any comment:	

Data / Parameter:	$q_{wcm,product}$
Data unit:	Nm ³ waste energy/ton slag
Description:	Specific waste energy production per unit of product generated
Source of data used:	Project participant
Value applied:	Average 2008 – 2010: 542
Justification of the choice of data or description of measurement methods and procedures actually applied :	WECM is measured in Nm ³ and the main product of the ilmenite smelter is titanium dioxide slag. Calculated from energy balance. Refer to Annex 3.



Any comment:	
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B.6.3. Ex-ante calculation of emission reductions:

The following assumptions were used to calculate the ex-ante emissions reductions:

- The proposed start of the crediting period is 1 January 2013.
- Six internal combustion engines are fully operational at the start of the proposed crediting period (1 January 2013).
- A further two internal combustion engines are installed and are fully operational on 1 July 2013.

The baseline emissions (BE_y) were calculated using equation (1): $BE_y = BE_{EN,y} + BE_{flst,y}$
(1)

Year	BE_y	$BE_{EN,y}$	$BE_{flst,y}$
	tCO ₂ /y	tCO ₂ /y	tCO ₂ /y
2013	74 973	74 973	0
2014	82 511	82 511	0
2015	83 326	83 326	0
2016	85 806	85 806	0
2017	85 919	85 919	0
2018	85 919	85 919	0
2019	85 919	85 919	0
2020	82 511	82 511	0
2021	85 919	85 919	0
2022	85 806	85 806	0



The baseline emissions from the energy generated by the project activity ($BE_{EN,y}$) were calculated using equation (1a):

$$BE_{EN,y} = BE_{Elec,y} + BE_{Ther,y} \quad (1a)$$

Year	$BE_{EN,y}$	$BE_{Elec,y}$	$BE_{Ther,y}$
	tCO ₂ /y	tCO ₂ /y	tCO ₂ /y
2013	74 973	74 973	0
2014	82 511	82 511	0
2015	83 326	83 326	0
2016	85 806	85 806	0
2017	85 919	85 919	0
2018	85 919	85 919	0
2019	85 919	85 919	0
2020	82 511	82 511	0
2021	85 919	85 919	0
2022	85 806	85 806	0

The baseline emissions from electricity that is displaced by the project activity ($BE_{Elec,y}$) were calculated using equation (1a-1):

$$BE_{Elec,y} = f_{cap} \times f_{wcm} \times \sum_j \sum_i (EG_{i,j,y} \times EF_{Elec,i,j,y}) \quad (1a-1)$$

Year	$BE_{Elec,y}$	$EG_{i,j,y}$	$EF_{Elec,i,j,y}$	f_{wcm}	f_{cap}
	tCO ₂ /y	MWh	tCO ₂ /MWh	-	-
2013	74 973	72 089	1.04	1	1.00
2014	82 511	82 614	1.04	1	0.96
2015	83 326	82 614	1.04	1	0.97
2016	85 806	82 614	1.04	1	1.00
2017	85 919	82 614	1.04	1	1.00
2018	85 919	82 614	1.04	1	1.00
2019	85 919	82 614	1.04	1	1.00
2020	82 511	82 614	1.04	1	0.96
2021	85 919	82 614	1.04	1	1.00
2022	85 806	82 614	1.04	1	1.00



f_{cap} was calculated using equation (1g):

$$f_{cap} = \frac{Q_{WCM,BL}}{Q_{WCM,y}} \quad (1g)$$

Year	f_{cap}	$Q_{WCM,BL}$	$Q_{WCM,y}$
	-	Nm ³ /year	Nm ³ /year
2013	1.00	91 688 951	91 433 808
2014	0.96	91 688 951	95 475 607
2015	0.97	91 688 951	94 541 846
2016	1.00	91 688 951	91 809 288
2017	1.00	91 688 951	89 811 598
2018	1.00	91 688 951	91 419 555
2019	1.00	91 688 951	87 767 489
2020	0.96	91 688 951	95 475 607
2021	1.00	91 688 951	89 811 598
2022	1.00	91 688 951	91 809 288

Project emissions were calculated using equation (2):

$$PE_y = PE_{AF,y} + PE_{EL,y} + PE_{EL,import,y} \quad (2)$$

Year	PE_y	$PE_{AF,y}$	$PE_{EL,y}$	$PE_{EL,import,y}$
	tCO ₂	tCO ₂	tCO ₂	tCO ₂
2013	172	0	172	0
2014	185	0	185	0
2015	185	0	185	0
2016	185	0	185	0
2017	185	0	185	0
2018	185	0	185	0
2019	185	0	185	0
2020	185	0	185	0
2021	185	0	185	0
2022	185	0	185	0



Project emissions from grid electricity consumption were calculated using equation (2b):

$$PE_{EL,y} = EC_{PJ,y} \times EF_{CO_2,EL,y} \quad (2b)$$

Year	PE _{EL,y}	EC _{PJ,y}	EF _{CO₂,EL,y}
	tCO ₂	MWh	tCO ₂ /MWh
2012	172	165	1.04
2013	185	178	1.04
2014	185	178	1.04
2015	185	178	1.04
2016	185	178	1.04
2017	185	178	1.04
2018	185	178	1.04
2019	185	178	1.04
2020	185	178	1.04
2021	185	178	1.04

Emission reductions due to the project activity during the year y were calculated using equation (3):

$$ER_y = BE_y - PE_y \quad (3)$$

Year	ER _y	PE _y	BE _y
	tCO ₂	tCO ₂	tCO ₂
2013	74 801	172	74 973
2014	82 326	185	82 511
2015	83 141	185	83 326
2016	85 621	185	85 806
2017	85 734	185	85 919
2018	85 734	185	85 919
2019	85 734	185	85 919
2020	82 326	185	82 511
2021	85 734	185	85 919
2022	85 621	185	85 806
Total	836 771	1 839	838 610

**B.6.4 Summary of the ex-ante estimation of emission reductions:**

>>

Year	Estimation of project activity emissions (tonnes of CO ₂ e)	Estimation of baseline emissions (tonnes of CO ₂ e)	Estimation of leakage (tonnes of CO ₂ e)	Estimation of overall emission reductions (tonnes of CO ₂ e)
2013	172	74,973	0	74,801
2014	185	82,511	0	82,326
2015	185	83,326	0	83,141
2016	185	85,806	0	85,621
2017	185	85,919	0	85,734
2018	185	85,919	0	85,734
2019	185	85,919	0	85,734
2020	185	82,511	0	82,326
2021	185	85,919	0	85,734
2022	185	85,806	0	85,621
Total (tonnes of CO ₂ e)	1,839	838,610	0	836,771

B.7. Application of the monitoring methodology and description of the monitoring plan:**B.7.1 Data and parameters monitored:**

Data / Parameter:	$Q_{WCM,y}$
Data unit:	Nm ³ /year
Description:	Quantity of waste gas used for energy generation during year y
Source of data to be used:	Plant measurements records.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2013: 91,433,808 2014: 95,475,607 2015: 94,541,846 2016: 91,809,288 2017: 89,811,598 2018: 91,419,555 2019: 87,767,489 2020: 95,475,607 2021: 89,811,598 2022: 91,809,288
Description of measurement methods and procedures to be applied:	The waste gas flow rate is measured continuously with orifice plates. These readings will be aggregated monthly for use in the monitoring plan.
QA/QC procedures to be applied:	



Any comment:	
Data / Parameter:	$Q_{wcm,h}$
Data unit:	Nm ³ /hr
Description:	Quantity of WECM recovered in hour h
Source of data to be used:	Plant measurement records.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2013: 10,438 2014: 10,899 2015: 10,792 2016: 10,481 2017: 10,252 2018: 10,436 2019: 10,019 2020: 10,899 2021: 10,252 2022: 10,481
Description of measurement methods and procedures to be applied:	The waste gas flow rate is measured continuously with orifice plates. These readings will be aggregated monthly for use in the monitoring plan.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$t_{wcm,h}$
Data unit:	°C
Description:	The temperature of WECM in hour h
Source of data to be used:	Plant measurements records.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2013: 38 2014: 38 2015: 38 2016: 38 2017: 38 2018: 38 2019: 38 2020: 38 2021: 38 2022: 38
Description of measurement methods and procedures to be applied:	The temperature of WECM will be measured continuously using thermocouples, with an accuracy class of type K. These measurements will be averaged hourly. The thermocouples will be calibrated once per year, in accordance with the manufacturer's procedures.
QA/QC procedures to be applied:	
Any comment:	



Data / Parameter:	$t_{wcm,y}$
Data unit:	°C
Description:	Average temperature of Waste Energy Carrying Medium (WECM) in year y
Source of data to be used:	Plant measurements records.
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2013: 38 2014: 38 2015: 38 2016: 38 2017: 38 2018: 38 2019: 38 2020: 38 2021: 38 2022: 38
Description of measurement methods and procedures to be applied:	The temperature of WECM will be measured continuously using thermocouples, with an accuracy class of type K. These measurements will be average yearly. The thermocouples will be calibrated once per year, in accordance with the manufacturer's procedures.
QA/QC procedures to be applied:	
Any comment:	

Data / Parameter:	$d_{wcm,y}$
Data unit:	kg/Nm ³ at actual conditions
Description:	Average density of WECM at actual temperature and pressure in year y
Source of data to be used:	Standard data books
Value of data applied for the purpose of calculating expected emission reductions in section B.5	This parameter is not used in emission reduction calculations.
Description of measurement methods and procedures to be applied:	The average density of WECM will be determined from temperature and pressure measurements of the WECM.
QA/QC procedures to be applied:	
Any comment:	The value of density to be used for calculations will correspond to average temperature and pressure of WECM.

Data / Parameter:	$Q_{OE,y}$
Data unit:	MWh
Description:	Quantity of actual output energy during year y
Source of data to be	Generation plant measurement records



used:	
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2013: 75,655 2014: 86,463 2015: 86,463 2016: 86,463 2017: 86,463 2018: 86,463 2019: 86,463 2020: 86,463 2021: 86,463 2022: 86,463
Description of measurement methods and procedures to be applied:	The quantity of electricity supplied to the recipient plant will be measured continuously using an electricity meter. The meter readings will be aggregated monthly for use in the emission reduction report.
QA/QC procedures to be applied:	<p>A set of meters will be installed on the feed from the internal combustion engines. This set comprises of a main meter and a check meter. The check meter ensures accurate readings, and also serves as a backup meter. These meters are 4-quadrant billable class meters that are bi-directional.</p> <p>The electricity meters will be fitted with a telemetry system, and the data will be fed into the plant control system on a daily basis. The main and check meters will be reconciled daily to check if their readings are within a pre-defined accuracy band. If there are discrepancies, then a notification will be sent to the control room to advise the operator to attend to a problem with the meters. The electricity readings will be used for billing purposes and will be logged electronically for the purposes of calculating emission reductions.</p> <p>The information will be saved onto the Exxaro Resources Ltd Supervisory Control and Data Acquisition (SCADA) system, as well as Exxaro Resources Ltd on-site financial systems.</p>
Any comment:	

Data / Parameter:	$EG_{i,j,y}$
Data unit:	MWh
Description:	Quantity of electricity supplied to the recipient j by generator, which in the absence of the project activity would have sourced from i^{th} source (i is the grid) during the year y
Source of data to be used:	Recipient plant(s) and generation plant measurement records
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2013: 72,089 2014: 82,614 2015: 82,614 2016: 82,614 2017: 82,614 2018: 82,614 2019: 82,614 2020: 82,614



	2021: 82,614 2022: 82,614
Description of measurement methods and procedures to be applied:	The quantity of electricity supplied to the recipient plant will be measured continuously using an electricity meter. The meter readings will be aggregated monthly for use in the emission reduction report.
QA/QC procedures to be applied:	<p>A set of meters will be installed on each feed from the plant. This set comprises of a main meter and a check meter. The check meter ensures accurate readings, and also serves as a backup meter. These meters are 4-quadrant billable class meters that are bi-directional.</p> <p>The electricity meters will be fitted with a telemetry system, and the data will be fed into the plant control system on a daily basis. The main and check meters will be reconciled daily to check if their readings are within a pre-defined accuracy band. If there are discrepancies, then a notification will be sent to the control room to advise the operator to attend to a problem with the meters. The electricity readings will be used for billing purposes and will be logged electronically for the purposes of calculating emission reductions.</p> <p>The information will be saved onto the Exxaro Resources Ltd Supervisory Control and Data Acquisition (SCADA) system, as well as Exxaro Resources Ltd on-site financial systems.</p>
Any comment:	

Data / Parameter:	$EC_{PI,y}$
Data unit:	MWh
Description:	Additional electricity consumed in year y as a result of the implementation of the project activity. This electricity is consumed from the grid.
Source of data to be used:	Actual measurements, plant operational records
Value of data applied for the purpose of calculating expected emission reductions in section B.5	2013: 165 2014: 178 2015: 178 2016: 178 2017: 178 2018: 178 2019: 178 2020: 178 2021: 178 2022: 178
Description of measurement methods and procedures to be applied:	The quantity of electricity supplied to the recipient plant will be measured continuously using an electricity meter. The meter readings will be aggregated monthly for use in the emission reduction report.
QA/QC procedures to be applied:	A set of meters will be installed on each feed from the plant. This set comprises of a main meter and a check meter. The check meter ensures accurate readings, and also serves as a backup meter. These meters are 4-quadrant billable class meters that are bi-directional – this means that they subtract any electricity used



	<p>by the plant during start up, or when the plant is not producing electricity</p> <p>The electricity meters will be fitted with a telemetry system, and the data will be fed into the plant control system on a daily basis. The main and check meters will be reconciled daily to check if their readings are within a pre-defined accuracy band. If there are discrepancies, then a notification will be sent to the control room to advise the operator to attend to a problem with the meters. The electricity readings will be used for billing purposes and will be logged electronically for the purposes of calculating emission reductions.</p> <p>The information will be saved onto the Exxaro Resources Ltd Supervisory Control and Data Acquisition (SCADA) system, as well as Exxaro Resources Ltd on-site financial systems.</p>
Any comment:	

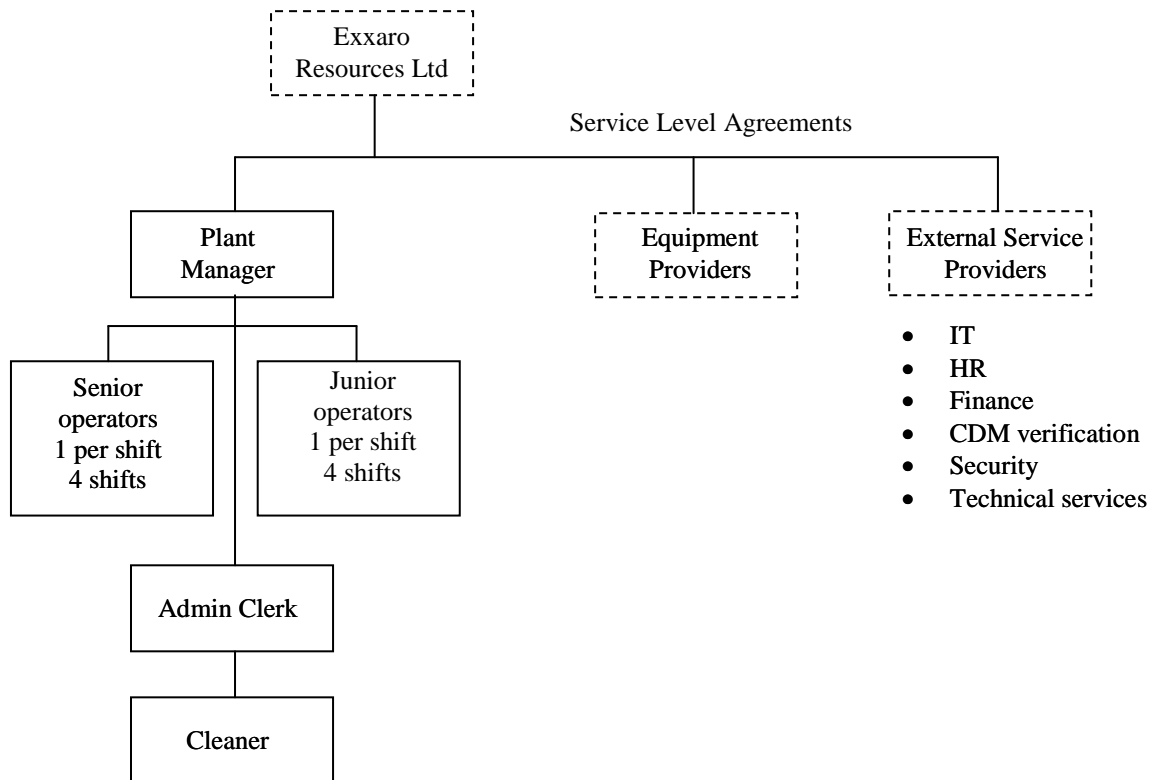
B.7.2. Description of the monitoring plan:

>>

The monitoring plan will ensure that emission reductions are accurately monitored, recorded, and reported.

- (i) Overall project management

Exxaro Resources Ltd has a clear and well defined management structure. This is illustrated in the operation organogram below.





(ii) Data to be monitored during the crediting period

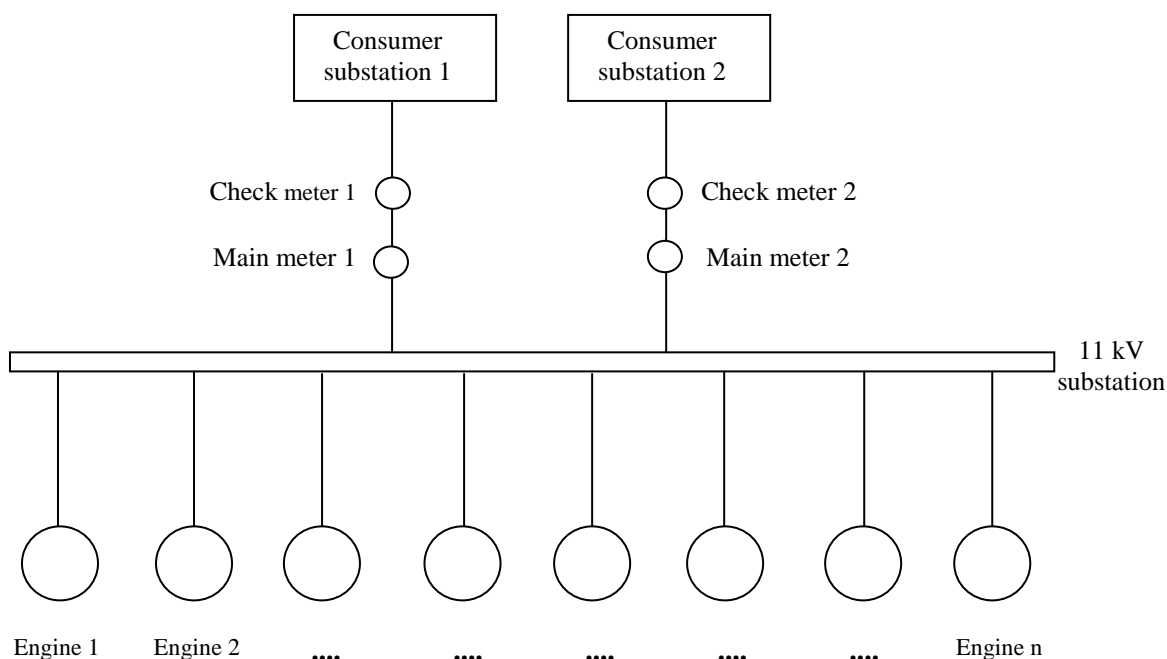
The following data will be monitored by Namakwa Sands:

- Quantity of electricity supplied to the recipient plant;
- Actual plant electricity output;
- Electricity consumption of additional plant equipment used in the project activity;

(iii) Monitoring equipment

Electricity meters will measure the quantity of electricity supplied to the recipient plant. These meters are 4-quadrant billable class meters that are bi-directional – this means that they subtract any electricity used by the plant during start up, or when the plant is not producing electricity.

Four electricity meters will be installed on the feeds to the recipient plant – two main meters and two check meters. The metering setup is illustrated in the diagram below.



(iv) Monitoring accuracy

The electricity meters will be fitted with a telemetry system, and the data will be fed into the plant control system on a daily basis. The main and check meters will be reconciled daily to check if their readings are



within a pre-defined accuracy band. If there are discrepancies, then a notification will be sent to the control room to advise the operator to attend to a problem with the meters.

(v) Data collection and storage

On a monthly basis, the Namakwa Sands plant manager (or other designated employee) and a representative from Namakwa Sands will read the two main electricity meters to determine the quantity of electricity produced by the plant. This will be done by adding the readings from the two main meters. The electricity readings will be used for billing purposes and will be logged electronically for the purposes of calculating emission reductions.

The information will be saved onto the Exxaro Resources Ltd Supervisory Control and Data Acquisition (SCADA) system, as well as Exxaro Resources Ltd on-site financial systems. Backups will be kept both on- and off-site, and all of the data will be available for CDM verification.

As per methodology ACM0012, all data collected as part of the monitoring plan will be archived electronically, and will be kept for a minimum of two years at the end of the crediting period.

B.8. Date of completion of the application of the baseline study and monitoring methodology and the name of the responsible person(s)/entity(ies):

>>

Date of completion of application: 11/11/2010

Contact information for the entity responsible for the application of the baseline and monitoring information:

Promethium Carbon (Pty) Ltd
Coral House
20 Peter Place
Bryanston 2021
Johannesburg
Telephone: +27 11 706 8185

This entity is not a project participant.

**SECTION C. Duration of the project activity / crediting period****C.1. Duration of the project activity:****C.1.1. Starting date of the project activity:**

>>

As per version 05 page 28 of the Glossary of CDM Terms, ‘the start date shall be considered to be the date on which the project participant has committed to expenditures related to the implementation or related to the construction of the project activity’.

The Exxaro Resources Limited Board conditionally approved the capital expenditure for the project at a Board meeting on 22/08/2011. The approval is conditional upon receiving a positive validation report as the revenue from carbon credits has been included in the financial model. To date, no significant expenses regarding equipment and infrastructure have been made.

The start date of the project is 31/07/2012. C.1.2. Expected operational lifetime of the project activity:

>>

The expected operational lifetime of the project activity exceeds ten years 0 months. The expected life of the furnaces and internal combustion engines exceeds the operational lifetime of the project activity. The service level agreement with the engine manufacturers is for 15 years.

C.2. Choice of the crediting period and related information:**C.2.1. Renewable crediting period:****C.2.1.1. Starting date of the first crediting period:**

>>

Not applicable

C.2.1.2. Length of the first crediting period:

>>

Not applicable

C.2.2. Fixed crediting period:**C.2.2.1. Starting date:**

>>

The starting date of the fixed crediting period is 01/01/2013.

C.2.2.2. Length:

>>



10 years 0 months

SECTION D. Environmental impacts

>>

D.1. Documentation on the analysis of the environmental impacts, including transboundary impacts:

>>

An initial environmental screening report for this project was undertaken by independent consultants; Strategic Environmental Focus (Pty) Ltd. This screening report identified the need to conduct a basic environmental assessment to comply with the National Environmental Management Act, 1998 (Act No. 107 of 1998) [NEMA], and the EIA Regulations of 2006 (Government Notice No's R385, 386 and 387 of 2006). A basic environmental assessment is a requirement for any project which generates over 10 MW of electricity, but under 20 MW of electricity.

The basic assessment is being conducted by Arcus Gibb (Pty) Ltd.

D.2. If environmental impacts are considered significant by the project participants or the host Party, please provide conclusions and all references to support documentation of an environmental impact assessment undertaken in accordance with the procedures as required by the host Party:

>>

An initial environmental screening report of the project activity and its associated environmental impacts was carried out by Strategic Environmental Focus (Pty) Ltd. They were required to make recommendations on the appropriate environmental authorisation processes for the project, to identify any potential environmental issues or sensitivities at the existing site and to highlight any environmental risks.

The process followed to compile the environmental screening report:

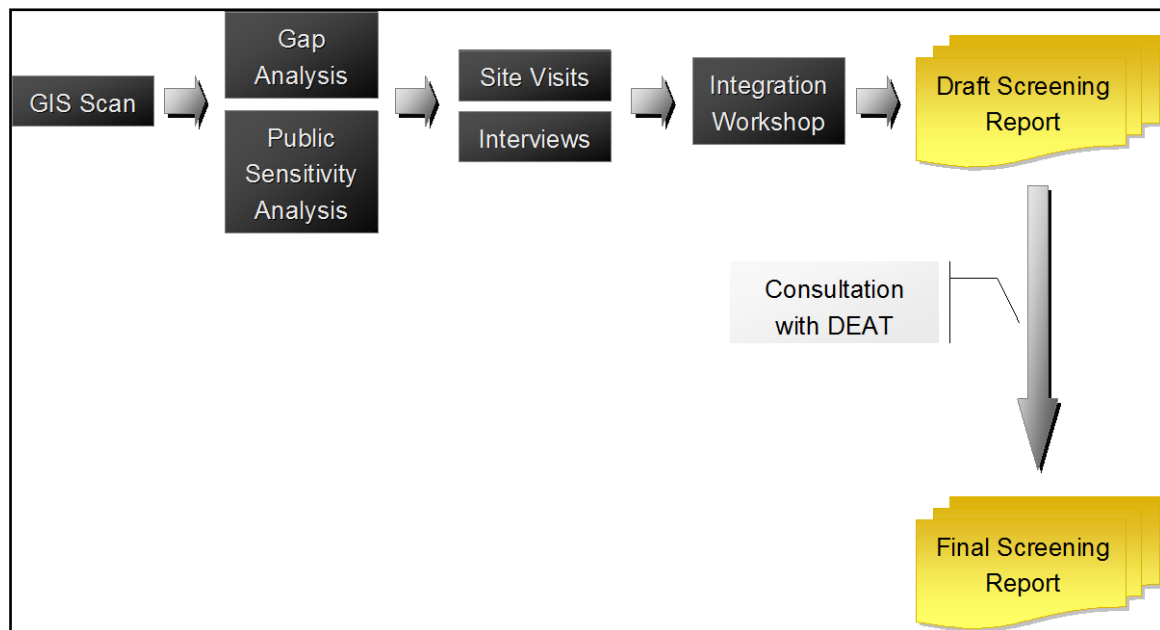


Figure 10: Screening report steps

The screening process determined that:

A basic assessment process will be required for the proposed plant to fulfil the requirements of South African environmental legislation. The proposed development involves 'listed activities', as defined by the National Environmental Management Act, 1998 (Act No. 107 of 1998) [NEMA], and the EIA Regulations of 2006 (Government Notice No's R385, 386 and 387 of 2006):

- Government Notice R386 of 2006:
 - 1 *The construction of facilities or infrastructure including associated structures or infrastructure, for: (a) the generation of electricity where the electricity output is more than 10 megawatts but less than 20 megawatts.*
 - 25 *The expansion of or changes to existing facilities for any process or activity, which requires an amendment of an existing permit or license or new permit or license in terms of legislation governing the release of emissions, pollution, effluent.*
- No water use license is required for the proposed plant. This is because the water will be supplied by Namakwa Sands who has sufficient headroom available on the water use permit;
- The proposed plant will result in an improved particulate removal system, which will result in a decrease in particulate matter released into the atmosphere (30 mg/Nm³ to below 15 mg/Nm³);
- The proposed plant on site may have a resultant increase in noise pollution on the site, but this has been addressed by housing the engines (equipped with exhaust silencers) in an engine room;

The basic assessment will be conducted by Arcus Gibb (Pty) Ltd.

**SECTION E. Stakeholders' comments**

>>

E.1. Brief description how comments by local stakeholders have been invited and compiled:

>>

Stakeholder consultation is required in South Africa. According to the National Environmental Management Act, 1998, Chapter 5, Section 24:

- (7) Procedures for the investigation, assessment and communication of the potential impact of activities must, as a minimum, ensure the following:
- (d) Public information and participation, independent review and conflict resolution in all phases of the investigation and assessment of impacts.

The following stakeholder consultation was conducted:

- A Background Information Document (BID) was released on 06/11/08 in order to provide interested and affected parties (I & AP) an opportunity to comment on the proposed project. In terms of the 'Regulations in terms of Chapter 5 of the National Environmental Management Act, 1998' (No. R. 385), an 'interested and affected party includes: any person, group of persons or organisation interested in or affected by an activity; and any organ of state that may have jurisdiction over any aspect of the activity'. In terms of this project activity, any person could register as an 'interested and affected party'. Once registered, these parties were given a 30-day public comment period in which to comment in writing about the proposed project activity.
- A regular Saldanha Bay Forum was held on 19/11/2008 at which the project was presented to the forum
- An open day was held at the Skilpadsaal in Vredenburg on 20/11/2008. The open day provided the public with an opportunity to get more information regarding the proposed project, and to provide inputs on the proposed project and basic assessment process. All I & AP were invited to attend the open day.
- Public participation notifications:
 - Newspaper advertisements: Weslander on 06/11/2008, and Coastal News on 14/11/2008
 - 6 on-site notices (3 in English, 3 in Afrikaans)
 - 68 email notifications/ invitations
 - 101 letters

E.2. Summary of the comments received:

>>

The table below gives a summary of the concerns and comments/suggestions raised by interested and/or affected parties during the 30 day public comment period.



Comment	Raised by	Response
<i>1. General environmental impacts</i>		
Degradation of the environment is a concern which should be addressed.	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	The proposed development will take place on the same site as the existing smelter. As a result, the site is highly disturbed and the ground cover comprises of bare soil and concrete.
The initiative is supported by the CWCBR, subject to compliance with all the relevant procedures and legislation.	Nicole Loebenberg (Cape West Coast Biosphere Reserve)	We take note of your comment.
The Draft BAR is satisfactory.	Anna Swartz (Help Mekaar Diensentrum)	We take note of your comment.
<i>2. Water related impacts</i>		
The impact on underground water and drainage should be investigated, in the event that water should be used during the process.	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	No groundwater will be abstracted for this development. Water will be sourced from the Municipality. The site is not located on a shallow water table or on seasonally wet soils, and as such issues surrounding drainage are not expected.
<i>3. Noise impacts</i>		
Will the proposed development result in noise impacts or reduction?	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	It is anticipated that the noise generated by the proposed cogeneration plant will be negligible in comparison to that of the existing industrial operations. The installation of the cogeneration plant will adhere to all noise control regulations. The engines will be installed inside an enclosed building.
<i>4. Air quality impacts</i>		
The value of the proposed cogeneration plant is noted as it will reduce air pollution and generate electricity for the existing plant.	Joy Anne Joshua (Principal: Babbelbekkies Pre-Primary)	We take note of your comment.
Solid residues and emissions are	Donovan Cleophas (Principal:	Construction rubble will be



<p>areas of concern that should be investigated.</p>	<p>Steenberg's Cove Primary School)</p>	<p>disposed of via the municipal waste stream. Lubricating oil used in the engines will be recycled.</p> <p>Due to the nature of the project (re-routing the gas that is currently flared, through an engine) there will be no significant change to the air quality. A small amount of NO_x (nitrous oxides) and SO_x (sulphur oxides) will be emitted by the engine (these emissions are within European Standards. Emission values: NO_x < 500 mg/Nm³ (5% O₂) (from Jenbacher manual), but the CO emissions will be reduced from the current value of approximately 50mg/m³ to less than 10mg/m³. A small amount of CO will continue to be flared by the existing operations, but this will be reduced to approximately 10 to 15% of current volumes of flared gas. The overall environmental impact on air quality and climate will be positive, since it will reduce the volume of greenhouse gases emitted to the atmosphere.</p>
<p>5. <i>Employment opportunities and skills transfer</i></p>		
<p>The construction phase and business opportunities should be outsourced to local SMME's.</p>	<p>Gert van Zyl (Chairman: Saldanhabaai Business Chamber)</p>	<p>Construction will make use of local contractors as far as possible.</p>
<p>Expansion of Namakwa Sands infrastructure which can secure new jobs for young people in the area is supported.</p>	<p>Joy Anne Joshua (Principal: Babbelbakkies Pre-Primary)</p>	<p>We take note of your comment.</p>
<p>Workers will be attracted to the area during the construction phase. What will happen to these workers after construction is completed?</p>	<p>Donovan Cleophas (Principal: Steenberg's Cove Primary School)</p>	<p>Construction will make use of local contractors as far as possible.</p>
<p>Who will be the beneficiaries of the process?</p>	<p>Donovan Cleophas (Principal: Steenberg's Cove Primary School)</p>	<p>Cogeneration projects have been identified as an opportunity to alleviate the growing capacity</p>



		pressure on the electricity supply industry. As one of a number of cogeneration projects planned in South Africa, this project can potentially reduce the frequency of load shedding. Reliable power will be beneficial to the local community and businesses and to South Africa as a whole. Namakwa Sands will also benefit by being less reliant on Eskom for electricity.
<i>6. Safety and security</i>		
Issues surrounding safety on the work site should be addressed.	Donovan Cleophas (Principal: Steenberg's Cove Primary School)	All requirements in terms of the Occupational Health and Safety Act, 1993 (Act No.85 of 1993) and Namakwa Sands' occupational health and safety management system will be adhered to. Construction workers will be required to complete a site induction course before being allowed onto site.

E.3. Report on how due account was taken of any comments received:

>>

Although comments were received during the 30 day public comment period, the nature of the comments did not require any adjustments on the design, construction, or operation of the proposed project.

**Annex 1****CONTACT INFORMATION ON PARTICIPANTS IN THE PROJECT ACTIVITY**

Organization:	Exxaro Resources Ltd
Street/P.O.Box:	Roger Dyason Road
Building:	Exxaro Corporate Centre
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State/Region:	Gauteng
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Country:	South Africa
Telephone:	+27 12 307 5000
FAX:	+27 12 323 3400
E-Mail:	
URL:	
Represented by:	
Title:	Mr
Salutation:	
Last name:	Garner
Middle name:	
First name:	Thomas
Department:	
Mobile:	+27 83 609 1309
Direct FAX:	+27 12 307 4092
Direct tel:	+27 12 307 4034
Personal e-mail:	thomas.garner@exxaro.com



Annex 2

INFORMATION REGARDING PUBLIC FUNDING

Not applicable. No public funding was used in the development or implementation of the project activity.



Annex 3

BASELINE INFORMATION

The calculations for the grid emission factor of the Southern African Power Pool

The energy balance of the relevant sections of the plant is provided below, to prove that the waste energy was not a source of energy before the implementation of the project activity.



GAS CALCULATIONS 2008

	Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
	31	29	31	30	31	30	31	31	30	31	30	31

FURNACES

Furnace 1		Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
		31	29	31	30	31	30	31	31	30	31	30	31
Power setpoint	MW	25	25	25	25	25	25	25	25	25	25	25	25
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed on utilisation	%	78%	87%	82%	85%	88%	90%	87%	77%	52%	89%	87%	89%
Load factor	%	100%	88%	99%	100%	100%	100%	100%	100%	100%	100%	100%	100%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	3 740	3 355	4 089	4 042	4 427	4 301	4 209	3 520	2 539	4 478	4 218	4 421
Electrical energy consumption	MWh	14 430	13 283	15 151	15 336	16 615	16 298	16 235	14 399	9 414	17 158	16 174	17 212
Anthracite consumption	tons	1 487	1 370	1 563	1 550	1 723	1 635	1 616	1 382	953	1 778	1 610	1 723
Electrode consumption	tons	49	47	61	58	58	64	62	57	37	60	52	54
Average power	MW	19	19	20	21	22	22	22	19	13	22	22	22
Furnace 2		Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
		31	29	31	30	31	30	31	31	30	31	30	31
Power setpoint	MW	35	35	35	35	35	35	35	35	35	35	35	35
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed-on utilisation	%	84%	84%	80%	82%	85%	87%	72%	19%	78%	89%	88%	84%
Load factor	%	97%	90%	98%	99%	100%	100%	100%	100%	100%	100%	100%	100%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	5 541	4 814	5 509	5 435	5 618	5 844	5 117	1 164	5 346	6 209	6 101	5 805
Electrical energy consumption	MWh	21 212	18 322	20 503	20 446	22 316	22 032	19 010	5 376	19 789	23 295	22 583	21 893
Anthracite consumption	tons	2 218	1 915	2 035	2 088	2 290	2 242	1 923	505	2 073	2 406	2 310	2 215
Electrode consumption	tons	67	73	71	64	71	72	60	25	62	77	74	69
Average power	MW	29	26	28	28	30	30	25	7	27	31	31	29

GAS GENERATION

Furnace 1		Jan-08	Feb-08	Mar-08	Apr-08	May-08	Jun-08	Jul-08	Aug-08	Sep-08	Oct-08	Nov-08	Dec-08
		31	29	31	30	31	30	31	31	30	31	30	31
Carbon in anthracite & electrodes	t	1 385	1 277	1 463	1 449	1 606	1 531	1 512	1 297	893	1 657	1 498	1 601
Carbon in tapped iron	t	86	77	94	93	102	99	97	81	58	103	97	102
Carbon in gas	t	1 299	1 200	1 369	1 356	1 504	1 432	1 415	1 216	834	1 554	1 401	1 500



CO in gas	t	3 029	2 799	3 193	3 163	3 508	3 340	3 299	2 836	1 946	3 624	3 267	3 498
CO in gas	Nm3	2 424 062	2 239 785	2 555 449	2 531 327	2 807 123	2 672 672	2 640 240	2 269 696	1 557 334	2 899 768	2 614 740	2 798 997
Gas produced	Nm3	3 320 634	3 068 199	3 500 615	3 467 571	3 845 375	3 661 195	3 616 766	3 109 172	2 133 334	3 972 285	3 581 836	3 834 242
Gas flow rate	Nm3/hr	5 724	5 746	5 747	5 624	5 757	5 588	5 542	5 371	5 637	5 759	5 509	5 541
Slag tapped		5 568	5 315	6 125	5 992	6 591	6 299	6 329	5 503	3 770	6 990	6 132	7 002
Furnace 2													
Carbon in anthracite & electrodes	t	2 059	1 792	1 898	1 940	2 127	2 085	1 788	478	1 924	2 238	2 148	2 059
Carbon in tapped iron	t	127	111	127	125	129	134	118	27	123	143	140	134
Carbon in gas	t	1 932	1 681	1 772	1 815	1 998	1 951	1 670	451	1 801	2 095	2 008	1 926
CO in gas	t	4 506	3 920	4 132	4 233	4 660	4 549	3 894	1 052	4 201	4 886	4 682	4 491
CO in gas	Nm3	3 605 518	3 136 924	3 306 464	3 387 579	3 728 932	3 640 363	3 116 464	841 932	3 361 957	3 910 266	3 746 753	3 593 631
Gas produced	Nm3	4 775 520	4 154 866	4 379 422	4 486 859	4 938 983	4 821 672	4 127 767	1 115 142	4 452 923	5 179 160	4 962 586	4 759 776
Gas flow rate	Nm3/hr	7 722	7 778	7 326	7 527	7 591	7 506	7 448	7 115	7 718	7 626	7 537	7 457
Slag tapped		8 522	7 308	7 963	8 190	9 003	8 708	7 456	1 816	8 063	9 695	8 780	9 126
Furnaces Combined													
Gas produced	Nm3	8 096 154	7 223 065	7 880 037	7 954 431	8 784 357	8 482 867	7 744 534	4 224 315	6 586 257	9 151 445	8 544 423	8 594 018
Gas flow rate	Nm3/hr	13 447	13 524	13 074	13 152	13 348	13 094	12 989	12 487	13 355	13 385	13 046	12 999
Gas Users													
Anthracite burner	Nm3	122 259	108 410	118 750	120 074	132 432	127 928	116 787	62 265	99 882	138 085	129 350	129 959
Proposed slag plant burner	Nm3	-	-	-	-	-	-	-	-	-	-	-	-
Available Gas													
Gas available for Cogeneration	Nm3	7 973 894	7 114 655	7 761 287	7 834 356	8 651 925	8 354 939	7 627 746	4 162 049	6 486 375	9 013 360	8 415 073	8 464 059
Average Gas Flow Rate													
(F1 gas minus gas users)	Nm3	3 198 374	2 959 789	3 381 865	3 347 497	3 712 942	3 533 266	3 499 979	3 046 907	2 033 452	3 834 201	3 452 486	3 704 283
(F2 gas minus gas users)	Nm3	4 653 261	4 046 457	4 260 672	4 366 785	4 806 550	4 693 744	4 010 980	1 052 877	4 353 040	5 041 075	4 833 236	4 629 817
F1 gas flow rate	Nm3/hr	5 724	5 746	5 747	5 624	5 757	5 588	5 542	5 371	5 637	5 759	5 509	5 541
F2 gas flow rate	Nm3/hr	7 466	6 962	7 116	7 433	7 539	7 456	7 385	6 855	7 699	7 574	7 491	7 402
Average flow rate from both furnaces	Nm3/hr	13 190	12 708	12 863	13 057	13 296	13 044	12 926	12 226	13 336	13 333	13 000	12 943



F1 FOU	%	78%	87%	82%	85%	88%	90%	87%	77%	52%	89%	87%	89%
F2 FOU	%	84%	84%	80%	82%	85%	87%	72%	19%	78%	89%	88%	84%
Check - F1		3 310 185	3 488 371	3 508 567	3 447 412	3 782 488	3 616 987	3 567 754	3 059 652	2 108 623	3 825 254	3 432 209	3 676 087
Check - F2		4 653 261	4 046 457	4 260 672	4 366 785	4 778 897	4 675 310	3 966 581	968 761	4 316 447	4 987 964	4 753 767	4 603 739
Check - OVERALL		-10 448	420 172	7 953	-20 159	-90 540	-62 642	-93 412	-133 637	-61 305	-200 141	-229 096	-184 234
Gas Calorific Value (Cogen gas)													
Reduction in gas flow rate	%	0	0	0	0	0	0	0	0	0	0	0	0
Gas calorific value	GJ/hr	147	141	143	145	148	145	144	136	148	148	144	144
Energy content of gas	MJ/Nm3	11	10	11	11	11	11	11	11	11	11	11	11

GAS CALCULATIONS 2009

	Jan-09	Feb-09	Mar-09	Apr-09	May-09	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09
	31	28	31	30	31	30	31	31	30	31	30	31

FURNACES

Furnace 1

Power setpoint	MW	25	25	25	25	25	25	25	25	25	25	25	25
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed on utilisation	%	86%	83%	66%									
Load factor	%	100%	100%	100%	0%	0%	0%	0%	0%	0%	0%	0%	0%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	4 297	3 658	3 155	-	-	-	-	-	-	-	-	-
Electrical energy consumption	MWh	16 771	14 548	12 883	-	-	-	-	-	-	-	-	-
Anthracite consumption	tons	1 653	1 448	1 294	-	-	-	-	-	-	-	-	-
Electrode consumption	tons	54	54	43	-	-	-	-	-	-	-	-	-
Average power	MW	22	21	17	-	-	-	-	-	-	-	-	-

Furnace 2

Power setpoint	MW	35	35	35	35	35	35	35	35	35	35	35	35
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed-on utilisation	%	86%	84%	83%	83%	81%	87%	85%	87%	91%	85%	86%	82%
Load factor	%	100%	100%	100%	100%	100%	100%	100%	100%	100%	90%	96%	100%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	5 952	5 082	5 528	5 383	5 520	5 790	5 747	6 035	6 165	5 274	5 525	5 592



Electrical energy consumption	MWh	22 640	19 797	21 585	21 186	21 365	22 311	22 251	22 995	23 302	19 738	20 816	21 407
Anthracite consumption	tons	2 299	2 020	2 176	2 130	2 151	2 219	2 236	2 363	2 384	1 991	2 121	2 188
Electrode consumption	tons	71	65	72	75	72	76	83	90	81	77	66	66
Average power	MW	30	29	29	29	28	30	30	31	32	27	29	29

GAS GENERATION**Furnace 1**

Carbon in anthracite & electrodes	t	1 538	1 354	1 205	-	-	-	-	-	-	-	-	-
Carbon in tapped iron	t	99	84	73	-	-	-	-	-	-	-	-	-
Carbon in gas	t	1 439	1 270	1 132	-	-	-	-	-	-	-	-	-
CO in gas	t	3 357	2 961	2 641	-	-	-	-	-	-	-	-	-
CO in gas	Nm3	2 686 198	2 369 867	2 113 210	-	-	-	-	-	-	-	-	-
Gas produced	Nm3	3 679 723	3 246 394	2 894 808	-	-	-	-	-	-	-	-	-
Gas flow rate	Nm3/hr	5 458	5 551	5 589	-	-	-	-	-	-	-	-	-
Slag tapped		6 747	5 891	5 162	-	-	-	-	-	-	-	-	-

Furnace 2

Carbon in anthracite & electrodes	t	2 136	1 879	2 026	1 988	2 004	2 069	2 090	2 211	2 222	1 864	1 971	2 031
Carbon in tapped iron	t	137	117	127	124	127	133	132	139	142	121	127	129
Carbon in gas	t	1 999	1 762	1 899	1 864	1 877	1 936	1 958	2 072	2 080	1 742	1 844	1 902
CO in gas	t	4 662	4 110	4 429	4 347	4 376	4 515	4 567	4 832	4 851	4 064	4 301	4 437
CO in gas	Nm3	3 730 763	3 289 297	3 544 028	3 478 531	3 502 181	3 613 073	3 654 489	3 867 009	3 881 702	3 251 985	3 442 114	3 550 553
Gas produced	Nm3	4 941 409	4 356 685	4 694 077	4 607 325	4 638 650	4 785 527	4 840 383	5 121 867	5 141 327	4 307 265	4 559 092	4 702 720
Gas flow rate	Nm3/hr	7 486	7 548	7 459	7 459	7 447	7 357	7 461	7 640	7 568	7 485	7 512	7 535
Slag tapped		9 343	8 174	8 910	8 622	9 027	9 227	9 333	9 502	9 520	8 506	8 763	9 079

Furnaces Combined

Gas produced	Nm3	8 621 132	7 603 079	7 588 885	4 607 325	4 638 650	4 785 527	4 840 383	5 121 867	5 141 327	4 307 265	4 559 092	4 702 720
Gas flow rate	Nm3/hr	12 944	13 099	13 049	7 459	7 447	7 357	7 461	7 640	7 568	7 485	7 512	7 535

Gas Users

Anthracite burner	Nm3	130 407	114 450	114 508	70 303	70 982	73 238	73 796	77 969	78 686	65 695	69 989	72 196
Proposed slag plant burner	Nm3	-	-	-	-	-	-	-	-	-	-	-	-

Available Gas



Gas available for Cogeneration	Nm3	8 490 725	7 488 629	7 474 377	4 537 022	4 567 668	4 712 288	4 766 587	5 043 898	5 062 641	4 241 569	4 489 103	4 630 524
Average Gas Flow Rate (F1 gas minus gas users)	Nm3	3 549 316	3 131 944	2 780 300	-70 303	-70 982	-73 238	-73 796	-77 969	-78 686	-65 695	-69 989	-72 196
(F2 gas minus gas users)	Nm3	4 811 001	4 242 235	4 579 569	4 537 022	4 567 668	4 712 288	4 766 587	5 043 898	5 062 641	4 241 569	4 489 103	4 630 524
F1 gas flow rate	Nm3/hr	5 458	5 551	5 589	-	-	-	-	-	-	-	-	-
F2 gas flow rate	Nm3/hr	7 437	7 484	7 426	7 495	7 483	7 392	7 498	7 677	7 604	6 734	7 232	7 571
Average flow rate from both furnaces	Nm3/hr	12 895	13 035	13 015	7 495	7 483	7 392	7 498	7 677	7 604	6 734	7 232	7 571
F1 FOU	%	86%	83%	66%	0%	0%	0%	0%	0%	0%	0%	0%	0%
F2 FOU	%	86%	84%	83%	83%	81%	87%	85%	87%	91%	85%	86%	82%
Check - F1		3 511 751	3 106 575	2 763 077	-	-	-	-	-	-	-	-	-
Check - F2		4 760 878	4 242 235	4 564 653	4 503 359	4 495 655	4 609 893	4 733 754	4 985 371	4 986 661	4 241 569	4 489 103	4 628 861
Check - OVERALL		-218 096	-139 819	-146 647	-33 663	-72 013	-102 395	-32 833	-58 527	-75 980	-	-	-1 663
Gas Calorific Value (Cogen gas)													
Reduction in gas flow rate	%	0	0	0	-0	-0	-0	-0	-0	-0	0	0	-0
Gas calorific value	GJ/hr	143	145	145	85	85	84	85	87	86	76	82	86
Energy content of gas	MJ/Nm3	11	11	11	11	11	11	11	11	11	10	11	11

GAS CALCULATIONS 2010

Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
31	28	31	30	31	30	31	31	30	31	30	31

FURNACES

Furnace 1		Jan-10	Feb-10	Mar-10	Apr-10	May-10	Jun-10	Jul-10	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10
Power setpoint	MW	25	25	25	25	25	25	25	25	25	25	25	25
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed on utilisation	%					41%	85%	91%	91%	88%	90%	89%	79%
Load factor	%	0%	0%	0%	0%	97%	100%	100%	100%	100%	100%	100%	100%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	-	-	-	-	5 497	3 867	4 590	4 639	4 660	4 863	4 585	4 067
Electrical energy consumption	MWh					7 459	15 433	17 482	17 708	17 996	18 208	17 995	16 593



Anthracite consumption	tons	-	-	-	-	713	1 560	1 771	1 834	1 765	1 879	1 760	1 593
Electrode consumption	tons	-	-	-	-	32	56	58	54	53	55	58	55
Average power	MW	-	-	-	-	10	21	23	23	22	22	22	20
Furnace 2													
Power setpoint	MW	35	35	35	35	35	35	35	35	35	35	35	35
Maintenance work	type	N	N	N	N	N	N	N	N	N	N	N	N
Feed-on utilisation	%	88%	87%	86%	82%		52%	32%	90%	82%	88%	87%	80%
Load factor	%	100%	100%	98%	100%	0%	95%	94%	74%	84%	88%	89%	88%
Days off line for major maintenance	days	-	-	-	-	-	-	-	-	-	-	-	-
Iron tapped	tons	6 188	5 345	5 938	5 389	-	2 953	1 972	4 505	4 521	5 415	5 044	4 807
Electrical energy consumption	MWh	23 019	20 436	21 860	20 504	-	12 477	7 850	17 299	17 396	20 101	19 376	18 336
Anthracite consumption	tons	2 386	2 100	2 269	2 142	-	1 209	736	1 763	1 754	2 049	1 966	1 869
Electrode consumption	tons	70	62	68	71	-	54	31	53	55	62	58	56
Average power	MW	31	30	29	28	-	17	11	23	24	27	27	25

GAS GENERATION

Furnace 1													
Carbon in anthracite & electrodes	t	-	-	-	-	671	1 457	1 649	1 701	1 638	1 743	1 639	1 485
Carbon in tapped iron	t	-	-	-	-	126	89	106	107	107	112	105	94
Carbon in gas	t	-	-	-	-	544	1 368	1 543	1 595	1 531	1 631	1 533	1 392
CO in gas	t	-	-	-	-	1 269	3 190	3 600	3 719	3 571	3 803	3 576	3 246
CO in gas	Nm3	-	-	-	-	1 015 703	2 552 695	2 880 556	2 976 227	2 857 366	3 043 469	2 861 722	2 597 383
Gas produced	Nm3	-	-	-	-	1 391 373	3 496 842	3 945 967	4 077 023	3 914 200	4 169 136	3 920 167	3 558 059
Gas flow rate	Nm3/hr	-	-	-	-	4 640	5 636	5 615	5 727	5 410	5 696	5 419	5 334
Slag tapped		-	-	-	-	2 394	6 263	6 992	6 859	6 705	7 201	6 844	6 438
Furnace 2													
Carbon in anthracite & electrodes	t	2 214	1 949	2 106	1 995	-	1 138	691	1 636	1 630	1 903	1 824	1 735
Carbon in tapped iron	t	142	123	137	124	-	68	45	104	104	125	116	111
Carbon in gas	t	2 072	1 826	1 970	1 871	-	1 070	646	1 533	1 526	1 779	1 708	1 625
CO in gas	t	4 832	4 258	4 593	4 363	-	2 495	1 507	3 574	3 559	4 148	3 984	3 790
CO in gas	Nm3	3 866 887	3 407 453	3 675 657	3 491 233	-	1 996 915	1 205 600	2 860 287	2 848 355	3 319 481	3 188 206	3 032 587
Gas produced	Nm3	5 121 705	4 513 183	4 868 420	4 624 149	-	2 644 921	1 596 821	3 788 460	3 772 655	4 396 664	4 222 790	4 016 671
Gas flow rate	Nm3/hr	7 632	7 575	7 639	7 736	-	7 271	6 977	7 512	7 439	7 502	7 475	7 514



Slag tapped		9 513	8 466	9 153	8 583	-	4 706	2 874	6 820	6 748	8 084	7 920	7 555
Furnaces Combined													
Gas produced	Nm3	5 121 705	4 513 183	4 868 420	4 624 149	1 391 373	6 141 762	5 542 788	7 865 483	7 686 856	8 565 800	8 142 957	7 574 730
Gas flow rate	Nm3/hr	7 632	7 575	7 639	7 736	4 640	12 908	12 591	13 239	12 849	13 198	12 894	12 848
Gas Users													
Anthracite burner	Nm3	78 751	69 314	74 862	70 691	23 516	91 362	82 751	118 687	116 101	129 618	122 966	114 269
Proposed slag plant burner	Nm3	-	-	-	-	-	-	-	-	-	-	-	-
Available Gas													
Gas available for Cogeneration	Nm3	5 042 954	4 443 869	4 793 558	4 553 458	1 367 857	6 050 401	5 460 036	7 746 796	7 570 755	8 436 182	8 019 991	7 460 461
Average Gas Flow Rate													
(F1 gas minus gas users)	Nm3	-78 751	-69 314	-74 862	-70 691	1 367 857	3 405 480	3 863 216	3 958 336	3 798 099	4 039 518	3 797 201	3 443 790
(F2 gas minus gas users)	Nm3	5 042 954	4 443 869	4 793 558	4 553 458	-23 516	2 553 559	1 514 069	3 669 773	3 656 554	4 267 046	4 099 824	3 902 403
F1 gas flow rate	Nm3/hr	-	-	-	-	4 640	5 636	5 615	5 727	5 410	5 696	5 419	5 334
F2 gas flow rate	Nm3/hr	7 668	7 611	7 531	7 754	-	6 828	6 361	5 482	6 167	6 535	6 571	6 556
Average flow rate from both furnaces	Nm3/hr	7 668	7 611	7 531	7 754	4 640	12 465	11 976	11 209	11 577	12 231	11 990	11 889
F1 FOU	%	0%	0%	0%	0%	41%	85%	91%	91%	88%	90%	89%	79%
F2 FOU	%	88%	87%	86%	82%	0%	52%	32%	90%	82%	88%	87%	80%
Check - F1		-	-	-	-	1 431 308	3 450 290	3 812 558	3 857 812	3 444 750	3 801 186	3 460 387	3 126 679
Check - F2		5 035 000	4 426 047	4 793 558	4 553 458	-	2 553 559	1 514 069	3 669 773	3 656 554	4 267 046	4 099 824	3 902 403
Check - OVERALL		-7 954	-17 823	-	-	63 451	-46 552	-133 409	-219 211	-469 450	-367 949	-459 780	-431 380
Gas Calorific Value (Cogen gas)													
Reduction in gas flow rate	%	-0	-0	0	-0	-	0	0	0	0	0	0	0
Gas calorific value	GJ/hr	87	86	85	88	50	138	133	124	129	136	133	132
Energy content of gas	MJ/Nm3	11	11	11	11	11	11	11	9	10	10	10	10



page 77

Annex 4

MONITORING INFORMATION
